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Engineering News-Record

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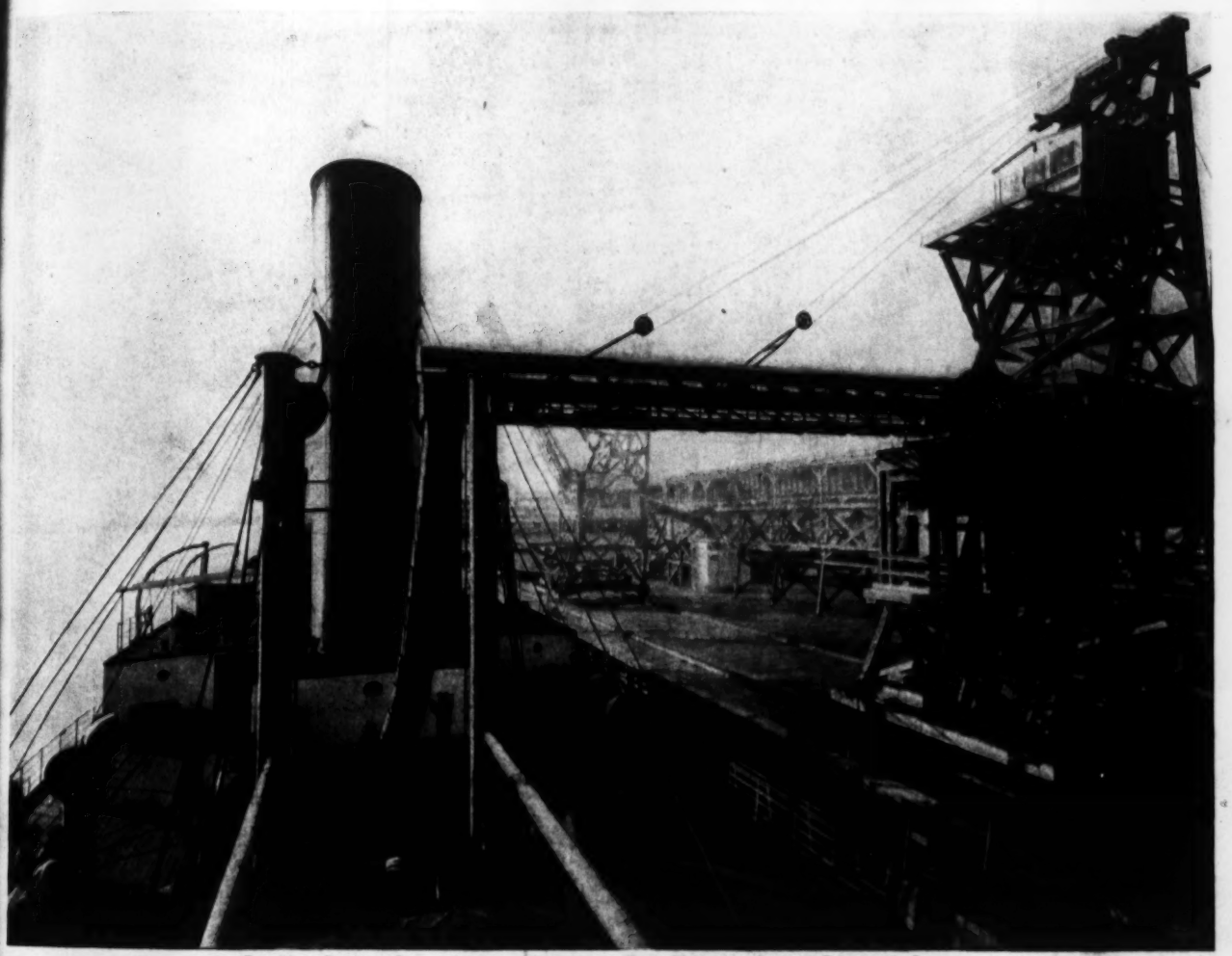


Loading Coal on Ocean Steamer From New Bulk Handling Pier at Portland, Oregon

Stress Coefficients for Large Horizontal Pipe
By James M. Paris

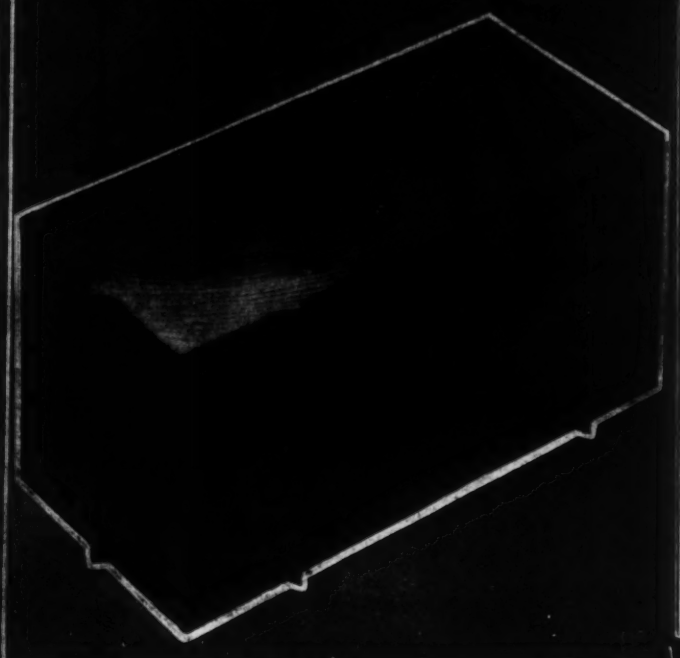
Changing No. 1 Broadway Into a Modern Office Building
By T. Kennard Thompson

New Bulk Handling Pier at the Port of Portland, Oregon
By G. B. Hegardt

Some Strength Tests and Economy Analyses of Light-Weight Aggregate for Concrete

KREOLITE LUG WOOD BLOCKS

Outlast the Bridge



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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

Volume 87 — NEW YORK, NOVEMBER 10, 1921 — Number 19

The Disarmament Conference

IT IS not our purpose to discuss here at length the limitation of armaments, but we cannot refrain in the week in which the disarmament conference convenes from adding our voice to the hopeful, acclaiming chorus from all over the world. The task is a mighty one but who shall say that it is insuperable when it is backed by the public opinion of the whole world! We have just come through the logical result of the nursing of armaments and the accompanying sword rattling. Few are so optimistic as to expect either complete disarmament or an end to war, but still fewer need to be persuaded that relatively disarmed nations are less apt to try the issue of war than those that are heavily armed. Newspaper and magazine discussion has approached the conference chiefly as a means of relieving the world from the oppressing costs of armaments. The terrific cost constitutes a valid argument. Past wars hold a heavy mortgage on the business of every nation. The consequent taxes press on the whole world and, while they may be uppermost in the minds of many who are publicly discussing the disarmament conference, their appeal is not more substantial and not half as pitiful as the prayers of the millions of those bereft in the late war. These particularly raise appealing hands to those who will assemble in Washington, begging that the danger of a repetition of these horrors may be removed as far as possible.

We pray for a fine success of the labors of the Washington conference.

Too Many Pier Fires

ONCE more a million or so has gone up in smoke in a shipping pier fire in New York harbor. This is one way to modernize port facilities but it is a pretty expensive one. Nevertheless, the frequency of such fires in all the ports of this country would lead an outsider to believe that there is a theory that the way to get new piers is to burn down the old ones, together with a respectable quantity of merchandise that necessarily is stored in such terminals. These frequent fires ought to be reduced, if not stopped altogether. There is nothing about a shipping pier that makes its fire hazards extraordinarily high. On the contrary both in the matter of fire resistance and fire protection its problems are easy compared to most buildings. That there are so many destructive pier fires indicates a lack of proper interest and control on the part of those responsible, a too easy acquiescence in the existence of dangerous conditions and of insufficient structures.

A World Reserve Bank

WHETHER it is possible to organize a world reserve bank to stabilize the whole economic situation, as has been proposed by Frank A. Vanderlip, the New York financier, remains to be seen. Apparently the details have not yet been fully considered by the great banks of issue and other financial agencies. The plan, though, looks in a direction that bears universal indorsement from those who realize the difficulties of the present situation. International financial stabilization more quickly than any other step would start the world's industries toward normal functioning. If the identical plan proposed by Mr. Vanderlip—which apparently is an amplification of the one he advanced two years ago—does not get support it may furnish the basis of a final plan. The acuteness of the financial situation is greater now than when he proposed the previous plan. That is apparent from the hope expressed in British financial circles that the disarmament conference would approach the question of financial stabilization.

Making Superpower Practical

SUPERPOWER is a rather grandiose term for what has been common enough in engineering practice—the interconnection of power plants with the consequent savings due to leveling of peak loadings and to the economies of co-ordinated operation. Wherein the so-called superpower survey is new is the application of these principles to a large industrial area—the largest in fact in the country—and the viewing of that district as an engineering entity rather than as a collection of political and financial separates. This is useful work which gives the necessary base data upon which future plans can be made and visualizes for the financier and legislator just what the engineer has to offer toward the reduction in the cost of living. It must be admitted, however, that considering how the world of business now thinks, it is a highly idealistic matter. To consolidate the many sources of power and the many lines of distribution, to say nothing of the many systems of railroads, so that they not only work in mutual harmony but in conformance with state and federal law and control is a herculean task, which the lawyer, the legislator and the financier must attack. The engineer has pointed out the way; it remains for some one else to find the means.

Vacillating Connecticut

CONNECTICUT legislatures continue to vacillate in matters relating to the study of stream pollution. Some years ago these studies were put in charge of a State Sewerage Commission, but after a relatively short time the work of this commission was brought to a close. The State Board of Health appears to have had some control of the subject at times. A year or two ago an Industrial Waste Commission was created to work in conjunction with the State Department of Health. Recently, after much controversy, the legislature abolished this commission and created a Stream Pollution Commission, noted here last week, at the same time taking all connection with the subject away from the State Department of Health. The new commission has no funds. There have been able engineers connected with the various earlier investigations, and the present commission is strong in this respect;

but no commission can accomplish much without funds, and why the Connecticut legislators cannot hold to any one policy is a nutmeg that we must leave for the citizens of that state to crack.

Pipe Analysis Analyzed

OF THE engineering problems that persistently elude all attempts to apply approximate calculation, the design of large horizontal pipes is one of the most baffling. It is related to the arch problem, having the same inherent difficulties, but raised to a higher power, since the pipe is in effect an unsymmetrical double arch of undetermined span lengths and subjected to unbalanced loads—conditions which remove the possibility of utilizing the simplifications applicable to the arch itself. No method of solution but the tedious one of complete analysis of the individual case of practice has been available for pipe design. An ingenious flank attack on the problem is made by the expedient set forth by J. M. Paris in this issue. He resorts to the expedient of analyzing the general case of the pipe into a number of fixed, elementary cases. By working out the elastic analysis for each of these, he cuts the knot of the difficulty, since the results may be combined by simple addition in proportion as the several elementary loadings are contained in the actual loading of any given practical case. This expedient makes it possible to deal with any kind of support and any kind of loading, and thus constitutes a method noteworthy for its power and flexibility. The value of the method is to be reckoned not merely in terms of the labor it will save, but also in terms of the errors and missteps which it will prevent, by supplying definite knowledge of pipe strength in the large number of instances where, without the Paris formulas, pure guesswork would be relied on.

The Fear of Unemployment

A WELL-KNOWN English manufacturer, B. S. Rowntree, is in the United States studying our handling of industrial relations. Incidentally, he has been telling groups of manufacturers and business men his own views on ways of eliminating labor unrest and disputes. His suggestions are not new, but he gives one of them an emphasis that fits in just now with the thinking of American business men. He lays down intelligent rules for wages, for hours of employment, for workers' representation and for profit sharing, but contends that economic insecurity—the ever-present danger of loss of employment—is the most potent cause of industrial unrest. This is the point that fits in with our thinking here, since his suggestions come at a time of great unemployment and immediately after the deliberations of the President's Conference on Unemployment.

The astonishing aspect of Mr. Rowntree's consideration of the subject was his unqualified statement that, while this is the most serious of the causes of industrial unrest, it is the easiest to cure. At Washington recently we considered that the solution was not easy to find. We, however, were proceeding on the theory that the only remedy for unemployment was employment. Mr. Rowntree agrees that this is the best remedy but he does not consider it the only remedy. He proposes a system of mutual unemployment insurance, through a fund to which both employers and employees would contribute. He suggests three methods of procedure: through the State, through groups of industries and by individual industries. In his own organization a 1 per cent reserve on the wage bill is the employer's contribution to the fund.

By many employers, Mr. Rowntree's suggestion of unemployment insurance will be met by the trite rejoinder that it is "socialistic." With fair-minded people who understand that industrial functioning is not a mere private enterprise but is essentially a social activity—a means by which people live and develop and multiply—this rejoinder has no force. The proper attitude is that it is the employer's obligation to consider without prejudice any means that will help reduce the dangers of conflict. We were told a decade ago that workman's compensation acts were a socialistic venture. Today there is common agreement that industrial accidents are a proper industrial charge.

We hold with Mr. Hoover and the delegates to the Unemployment Conference, that it is very desirable to attack the problem of unemployment by devising some method, based upon adequate statistics, of securing the deferment of construction work in boom times to fill up the valley of depression. Nevertheless, thought along the lines suggested by Mr. Rowntree, is needed. Dr. Steinmetz said years ago that the three great fears of workers were the fear of ill-health, of unemployment, and of unprovided-for old age. The industries that will remove these fears will acquire a thoroughly loyal force and one that will not furnish ground for cultivation by agitators. In such companies the efforts of organized labor are helpless because organized labor cannot do as much for the employees as the employers are voluntarily giving.

Relief Valves Must Function

A SERIOUS accident to the penstock of a Western hydro-electric plant, recently discussed in these pages, serves as a reminder that after rapid advances have been made in any field it is good practice to make a survey of all features affected by the new conditions to see what new problems and possibilities have been introduced. In going over recent developments in hydraulic turbines with that attitude of mind, it is to be noted that the relief valve or pressure regulator has been affected perhaps more than any other feature of hydraulic equipment by the trend in recent years toward higher heads and larger units.

Despite this the relief valve is too often regarded as merely an item on the list of turbine accessories which, once installed, can be passed by the inspector much as he would check off a shaft bearing or a grease cup. Inquiry of a well-known manufacturer of hydraulic equipment develops the fact that only one purchaser in fifty asks about the details of the pressure regulator on his turbine. This is surprising when it is remembered that under modern conditions there is no more vital part in the entire mechanism of the hydro-electric plant. So many combinations of load and pressure may arise that must be met and balanced by different speeds of opening or closing the relief valve that only a complex mechanism could perform all the necessary functions. In addition to this complexity of operation, when the mechanism is called upon to perform heavy duty, as is the case with modern units of large size and high head, it is apparent that the pressure regulator must be accurate and dependable in its operation and of rugged construction. Moreover, even a relief valve properly designed and suited to the characteristics of

the plant in which it is installed still requires to be adjusted under operating conditions. Because of the variety and importance of the operations it is to perform automatically, it is safe to say that in testing out and adjusting a new installation the pressure regulator is likely to require more time and attention than the turbine itself.

When finally put on its own resources, as it were, in the expectation that it will function automatically, the relief valve should fulfill the following conditions: (1) It must be absolutely positive in its opening, (2) after opening it must be absolutely controllable in the rate of closure and equally positive in effecting complete closure, (3) it must open partly and inversely with the closure of the turbine guide vanes when such closure so checks the water flow in the pipe line that relief is necessary to prevent dangerous water ram, but it must remain closed for any movement of the guide vanes that is not of sufficient magnitude to adversely affect the pipe line pressure. These are operating requirements apart from and in addition to the need for perfection of mechanical details, accessibility, simplicity of maintenance and the various other features which will at once be recognized as essential if the plant is to be protected from those dangers against which the relief valve is designed to guard.

Power companies and engineers will do well to give careful thought to the modern relief valve as a separate and distinct feature of the installation worthy of consideration on a par with the turbine itself. The best turbine produced can be sent to the scrap heap by a relief valve that does not function properly.

A Question of Highway Efficiency

AT THE foot of a grade in a road over which the editor recently passed there is a gully crossed by a newly planked bridge. A warning sign on the approach announced; "This Bridge Closed to Loads over 4 Tons." Some miles farther along, a reminder of horse-and-buggy days appeared in the shape of a venerable bridge bearing the notice, "Five Dollars Fine for Driving Faster Than a Walk." Still a little farther, a more modern note was sounded by another bridge sign, "Slow Down to 8 Miles. Heavy Trucking Prohibited." An automobile rattling at 20-mile speed over the 8-mile bridge threw doubt on the effectiveness of these signs. But, effective or not, they told plainly that our costly highway system is limited in its utilization by inadequate bridges.

Another side of the story is given by Mr. Goldmark's letter in this issue, reporting a bridge that has been allowed to get into a menacing state of disrepair, and to remain so. There are other bridges as dangerous as the one described, though fortunately not many. Supine or ignorant local officials do happen, and sometimes, as in a recent intercounty bridge case, when one county barricaded a weak bridge and the other county pulled down the barriers, there are cases of sheer obstinacy. It is not open to doubt that where such governmental conditions operate to make bridges dangerous, a cure for the evil needs to be found; but it is not so obvious that the cure lies in state control.

We have thus a twofold problem of inadequate bridges that reacts—more and more seriously as time goes on—to the detriment of highway efficiency. It is concerned with well-preserved but obsolete bridges, and with those which are in bad disrepair.

What is to be done? The problem arises from the fact that the most remote bridge, formerly a thing of purely local value, is of widest concern now that power-driven road traffic comes and goes everywhere, while the burden of rebuilding rests in large part on the local residents. They paid for the old bridge, and it still satisfies their needs in the main, while the new one will serve chiefly strangers, they think. Their reluctance to undertake the improvement is thus rather natural. But even though chargeable in part to a kind of selfishness, it is also chargeable to a slender purse. The plain fact is that neither a single township or county, nor a whole state or the nation is able to solve all at once the bridge problem that has been created overnight by the mushroom growth of highway traffic.

Numerous agencies are working on bridge improvements: State highway authorities, many able county boards, the federal Bureau of Public Roads. Yet they are only grazing the surface. In the main they do no more than provide the currently-improved main roads with bridges of ample strength and size. At times they perform remarkable feats, such as the quick rebuilding of the Patuxent River bridge by J. N. Mackall, recorded last week. But financial miracles are beyond their power. They cannot, in a month or a season, tear down all the bridges on by-roads as well as main highways and replace them with 20-ton standards. The attempt would strain our credit system and disrupt our markets.

The problem is obvious; inadequate bridges will continue to exist for a long time, their number decreasing only slowly. Some things may be done to make it less serious. Where a bridge is a traffic danger if not posted, it must be posted. Where the inadequacy of bridges reduces the value of an entire road system, means must be sought to limit this effect; a primary network of full-capacity roads, supplemented by auxiliary networks of graded road-capacities, can be made highly effective, provided proper publicity is given to the arrangement. All the time, moreover, bridge replacement must proceed as rapidly as public moneys (and the earnings of the road system, once we systematize the collection and allocation of these earnings) permit. Unless these things be done—few states are even making an approach to doing them—weak or defective bridges will continue unduly long to throttle transportation and threaten life.

But there is a point of more immediate professional concern that is raised by Mr. Goldmark's reference to the value of publicity, and his striking demand for action by the engineering societies. The point is that to the public, much as we ourselves may look upon highway bridges as routine products of standard designing and construction methods—to the public, bridges are works of engineering, fully understood only by engineers and guaranteed to the community by the profession as a body. The guarantee cannot be repudiated by the profession, and it remains for the societies to stand back of this guarantee. They can surely be of service in the matter of defective bridges; they have means for ascertaining the facts, can warn by public notice, and in case of need can resort to more direct compulsion. It is almost equally certain that they can aid by other methods in the solution of the more general highway bridge problem, as involved in the gradual replacement of structures outgrown by the traffic. The starting-point is recognition of the fact that, in its relation to the community, organized engineering stands behind the integrity of our bridges.

Bulk Handling Plant at Port of Portland, Ore.

City Builds Addition to Municipal Ocean-Vessel Terminal to Store and Move Phosphate Rock—Includes Box-Car Dumper and Belt Conveyor System

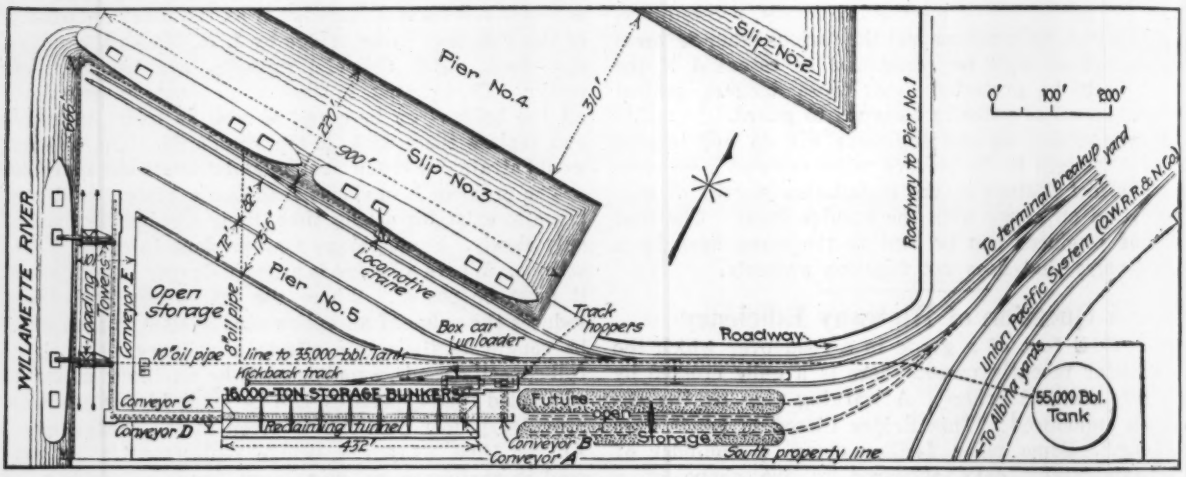
By G. B. Hegardt
Chief Engineer, the Commission of Public Docks, Portland, Ore.

FACILITIES for the storage and tran-shipment of large quantities of phosphate rock have been provided by the city of Portland, Ore., at its Terminal No. 4 on the Willamette River in the way of a wide pier, with deep water approach, storage bins, belt conveyors, traveling crane conveyors along the pier side and a box-car dumper. The complete installation is somewhat of a novelty in harbor design.

Since the Commission of Public Docks of the City of Portland was created and began functioning, in 1912, for the purpose of providing municipal, commercial terminal facilities for the port, four terminals have been constructed and approximately $8,950,000 expended from a total authorized bond issue of $10,500,000. Three of these terminals were completed prior to 1914, and the fourth, Municipal Terminal No. 4, is nearing completion, the amount so far expended there being about $4,700,000. When work on Terminal No. 4, a general description of which appeared in *Engineering News-Record*, Oct. 21, 1920, p. 796, was begun in 1918, the then adopted plan contemplated only the construction of a 1,000,000-bushel grain elevator, one pier and, tentatively, a vegetable oil storage plant. With the rapidly increasing commerce of the port, however, the demand for additional facilities has necessitated a practically continuous construction program at this terminal, until at this time, three piers have been placed in operation and work begun on a fourth pier. The dimensions and other features of these piers are given in the article above referred to.

In 1920, a demand was made on the commission to furnish handling and storage facilities for the transshipment, by ocean carriers, of large quantities of phosphate rock, principally to the Orient, from the immense deposits available in the states of Idaho and Montana, amounting, according to Government statistics, to billions of tons. This request for such bulk storage facilities was based on definite contracts then entered into for the shipment through the port of 165,000 tons of phosphate rock. Because of unfavorable financial conditions in the Orient these contracts were cancelled before the bulk storage plant was completed. In view, however, of the representations made at the time referred to, the commission decided to provide the facilities requested and proceeded with the construction of the plant herein described.

As noted on the plan, the bulk storage plant is on Pier No. 5, which is triangular in shape, the pier proper having a length of 900 ft. along slip No. 3 and the quay portion a frontage of 666 ft., the bulk storage plant paralleling the third leg of the triangle, where the most convenient trackage connections could be made available.

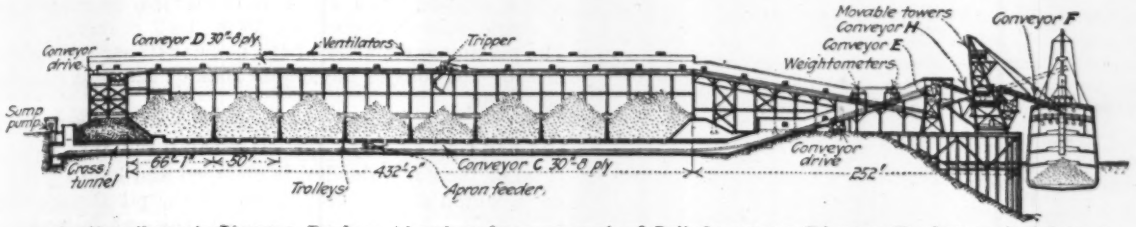


PLAN OF BULK STORAGE PIER, MUNICIPAL TERMINAL NO. 4, PORTLAND, ORE.

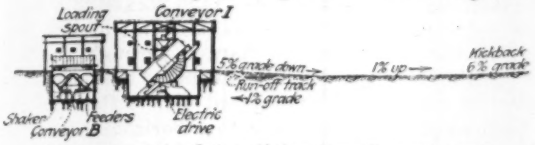
The elevation of the original surface of the ground of that portion of the site to be occupied by the bulk storage plant varied from 12 to 14 ft. above low water, the soil formation being a mixture of sand and clay, consisting of the usual river deposit found along the banks of silt-bearing streams. Because of the necessity of bringing the elevation of the terminal site to a considerable height above any possible river freshets and to effect the most practical connections with existing railroads immediately in rear of the terminal site, the entire terminal area was raised to an average elevation of 33 ft. above low water. This fill was made by pipe line dredges from material excavated from the ship channel and the three terminal slips. A total of about 3,250,000 cu.yd. of material was so placed on the 160-acre terminal site.

Consideration was given to various types of construction of the storage portion of the plant, both with reference to first cost and to maintenance. The design finally adopted was for concrete construction of bins, tunnels and hoppers, with shed and belt galleries to front of pier of wood, with galvanized iron covering.

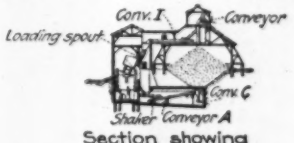
No piles were driven for the foundation of the concrete bins or tunnels, but a hydraulic fill was made over the site to the general elevation of +30 ft. and



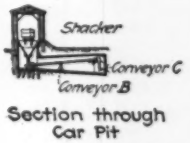
Section through Storage Bunkers showing Arrangement of Belt Conveyors, Trippers, Feeders and Drives



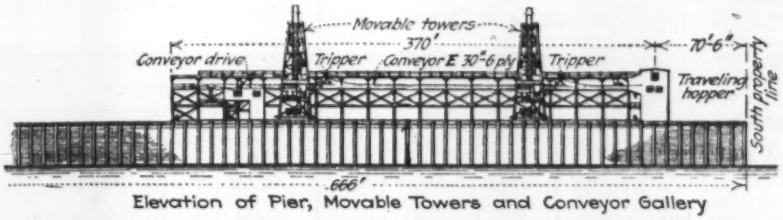
Arrangement of Car Unloading Devices and Trackage Leading to and from same



Section showing Bunkers and Box Car Unloader



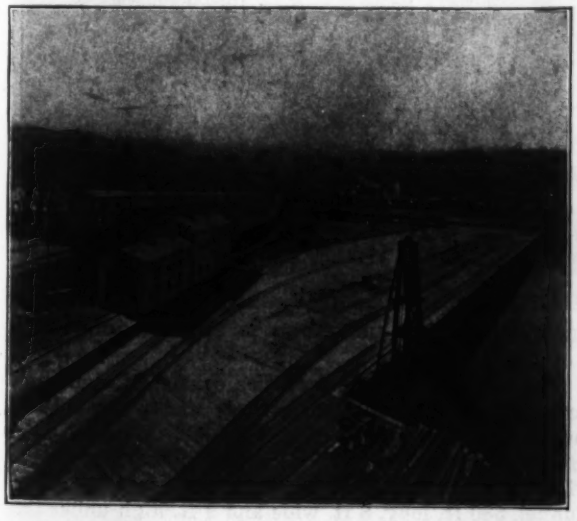
Section through Car Pit



Elevation of Pier, Movable Towers and Conveyor Gallery

ARRANGEMENT OF CONVEYOR SYSTEMS, CAR DUMPERS AND UNLOADER CRANES

this fill was later excavated, by clam-shell bucket, to the depth required for the reclaiming tunnel and the side slopes of the concrete bins. Upon the foundation thus prepared was constructed the concrete bunkers of the bulk storage plant. Piles were driven, however, for the foundation of the box car unloader and the track hopper. In the concrete tunnels, bin bulk-



LOOKING TOWARD THE WILLIAMETTE RIVER OVER THE BULK STORAGE PIER

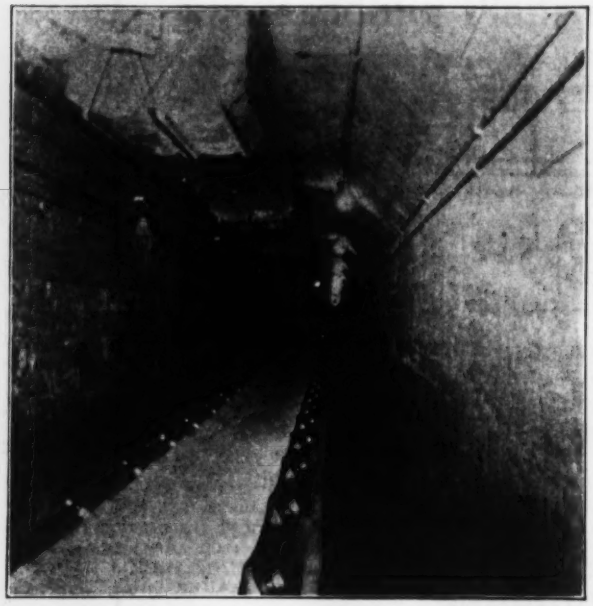
heads, track hopper and the foundation for the box car unloader, bar reinforcement was used and the bin side slopes were reinforced with wire mesh.

Because of the generally fixed elevation of the pier and trackage connections, it was necessary to carry the foundation of the reclaiming tunnel down to +12.7 ft. at the pier end, with a drainage slope of 2 ft. toward the inner, or shore end, where seepage water is collected in a sump of 230 cu.ft. effective capacity. The top elevation of the tunnel, at the pier, is +25.0.

No attempt was made to waterproof the tunnel, except by a 10 per cent addition of hydrate of lime in the concrete, which it was expected, would make the work sufficiently tight for the sump pump to handle any seepage water that would penetrate the concrete. That this worked out in an entirely satisfactory way was fully demonstrated during a recent freshet in the Columbia River, which produced a maximum back water stage in the Williamette River of +24.4 ft. with a stage of +20.0 ft. for a period of 34 days and a +15.0 ft. stage for 50 days. Very little trouble was experienced during this time from seepage, it being necessary to run the sump pump only twice an hour at maximum river stage to empty the sump and as the water receded to +20.0 ft. only once every hour.

The general layout and construction of this bulk storage plant, with its conveying machinery, is shown in accompanying plans and photographs. The conveyor machinery, including drives, traveling hoppers, trippers, chutes, automatic scales and traveling or

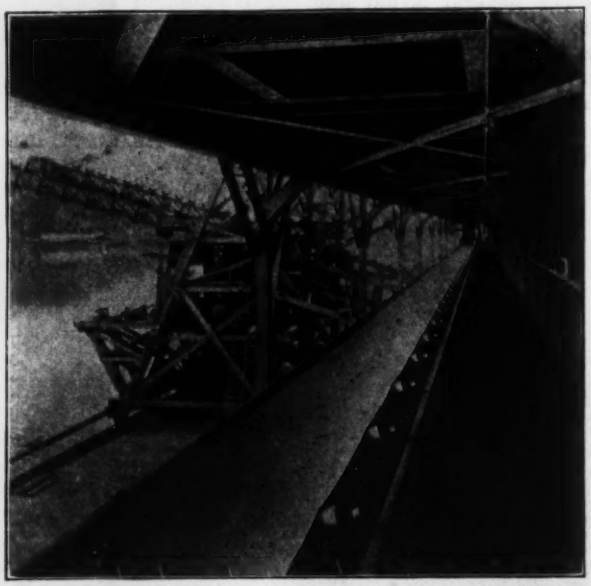
COALING A STEAMER BY THE UNLOADER CRANES



CONCRETE TUNNEL WITH CONVEYOR BELT "C" AND 20 X 30-IN. GATES IN ROOF

movable ship loading towers for handling bulk material, performs the following operations: (1), Delivery from hopper bottom cars to bunkers, or directly to vessel; (2), Delivery from box cars to bunkers, or directly to vessels; (3), Delivery from bunkers to vessels; (4), Delivery from vessel to bunkers; and (5), Delivery from bunkers to cars.

The unloading facilities consist of a box-car unloader, a double-hoppered track pit for unloading bottom dump gondolas and "Duplex" shaker feeders for discharging material from the hopper to 30-in. belt conveyor "B". The capacity of the track hopper is, approximately, 250 tons per hour for phosphate rock or 100 tons per hour for coal. The box car unloader and loader, manufactured by the Ottumwa Box Car Loader Co., discharges the contents of box cars into a hopper, from which it is carried, by means of a single shaker feeder, to 30-in. belt conveyor "A." The maximum capacity of the box car tipper is approximately 300 tons of phosphate rock or 125 tons of coal per hour.



BELT CONVEYOR "E", TRIPPER AND SHIP UNLOADERS

This machine will unload a standard box car by side and end tipping. The car, after being run onto a platform of the car unloader, is clamped and held rigid by dogs, which are brought up out of the pit at each end of cradle. After being clamped, the car is given a side maximum tip of 20 deg. and then rocked to a maximum inclination of 45 deg., causing all of the material in the car to be discharged through the car door opening into the concrete hopper. It is operated by electric motors and compressed air. After the car has been emptied it is brought to a horizontal position and is removed from the tipping platform by a car puller, which is also used to pull cars up the 3 per cent grade to the car unloading pits.

BOX CAR ON THE UNLOADER TIPPED FOR EMPTYING

The enclosed storage facilities consist of eight separate bins constructed of concrete and covered by a heavy mill constructed shed, 50 x 432 ft., which also covers belt conveyor "D" used for discharging material into the bunkers. A heavy reinforced-concret tunnel, 580 ft. long, 8 ft. wide and 9 ft. high under the bunkers, housing conveyor "C", is provided for transferring material from the bins to vessel or cars and also for receiving material from the car unloading hoppers.

The bins are sloped on an angle of 35 deg. and the material is discharged from the bins onto conveyor "C" in the tunnel below, through 20 x 30-in. "Duplex" gates and a powered apron feeder, operating on track above conveyor "C", delivers material from the bins onto conveyor "C".

The normal capacity of the eight covered storage bunkers is 16,000 tons of phosphate rock or 8,000 tons

of coal and maximum capacity, with bins fully heaped is 22,000 and 9,300 tons, respectively.

All material handled in the bulk storage plant is conveyed by nine 30-in. belt conveyors, varying in length from 35 ft. for "A" to 642 ft. for "D" and totaling 2,033 ft. The maximum capacity is 600 tons per hour of phosphate rock and 250 tons per hour of coal. Belts "C" and "D" are 8-ply, belts "F" and "G" 7-ply, belts "E" and "H" 6-ply. The others are 5-ply. All are driven by direct-connected electric motors through gear and pinion reductions. The troughing rolls are of standard type with five rolls. The return rolls are also of standard type.

Two traveling or ship's towers operate along the harbor face of Pier No. 5, for transferring material from the 30-in. belt conveyor on the pier to vessels. The towers can be spotted to any location along the pier and the spouting arrangement from the adjustable conveyor on the tower permits the material being delivered to vessel at any stage of the river.

For unloading vessels the movable towers are also provided with return belts for receiving material from vessels for delivery to bunkers or cars. The material being handled from vessels is hoisted by buckets or by clam-shell from the hold of the vessel and discharged into hoppers, located on the towers, and from these hoppers, 30-in. belt conveyors discharge the material onto belt "E" which is reversible, and material from belt "E" is likewise carried over belt "D" to the bunkers or cars. When sufficient business develops it is the intention of providing conveyors for taking material, such as coal, etc., from vessel's hold for delivery into the hoppers on the movable towers.

Two Merrick Scale Manufacturing Co. weightometers are provided, one being installed on conveyor belt "C" leading from the reclaiming tunnel and one on conveyor belt "D" leading to the bunkers. The weightometers automatically weigh the material while in transit on the conveyor belts, with a guaranteed accuracy of 99 per cent.

Electric Connections

The entire bulk storage plant is electrically operated, 440-volt, 60-cycle, alternating current being used. A complete system of remote control is provided for cutting off the power throughout the plant. The connected load of the entire plant is 600 hp. A system of electric bell and light signals is also installed for the operation of the plant, which is well lighted, both direct and flood lighting being used.

An automatic car puller delivers cars from the terminal tracks to the car unloading pits and a "kick-back" track is provided for taking care of the empty cars after being discharged at the pits.

At the shore end of the bunkers there is available ground storage space for about 20,000 tons of bulk material.

The general design of the conveyor system for the bulk storage plant is from a layout proposed by the Robins Conveyor Belt Co., but the machinery was manufactured locally by the Hesse-Martin Iron Works, on competitive bids. The detail plans and the construction of the entire plant were carried out by the commission's engineering department.

No phosphate rock has been handled through this plant, except for testing purposes. The box car unloader was given a thorough and satisfactory test, fully loaded box cars of phosphate rock being completely emptied in about 9 minutes. The bulk storage plant has been used to some extent for storage of coal and bunkering of vessels, and a delivery of 200 tons per hour was readily attained, with vessel's bunkers clear and no trimming required. The cost of the plant, exclusive of pier construction, was approximately $300,000.

Tests on Foundation Piers With 1,000-Ton Jack

Bearing Capacity of Concrete Piers 60 Feet Deep Being Tested in Chicago by 1,000-Ton Hydraulic Jack

LOADING TESTS on full-size foundation piers are being carried on at the Chicago Union Station, using a 1,000-ton hydraulic jack and a reaction load, to determine a safe load for hardpan at considerable depth. This work represents a new development in testing the bearing power of soil, since in most tests of this kind the loaded area is but one or two square feet.

At the site of the headhouse for the new station an 8-ft. bed of hardpan is met about 80 ft. below street level, or 65 ft. below city datum (water level in the river). Rock is 20 ft. deeper, and varied strata of sand and clay lie between the hardpan and the rock. Many large buildings at Chicago have their concrete foundation piers resting on hardpan, as the cost of sinking to a greater depth through the underlying soft strata did not warrant extending the piers to rock. In such cases the bottoms of the piers are belled out to a diameter about double that of the shaft in order to increase the bearing area.

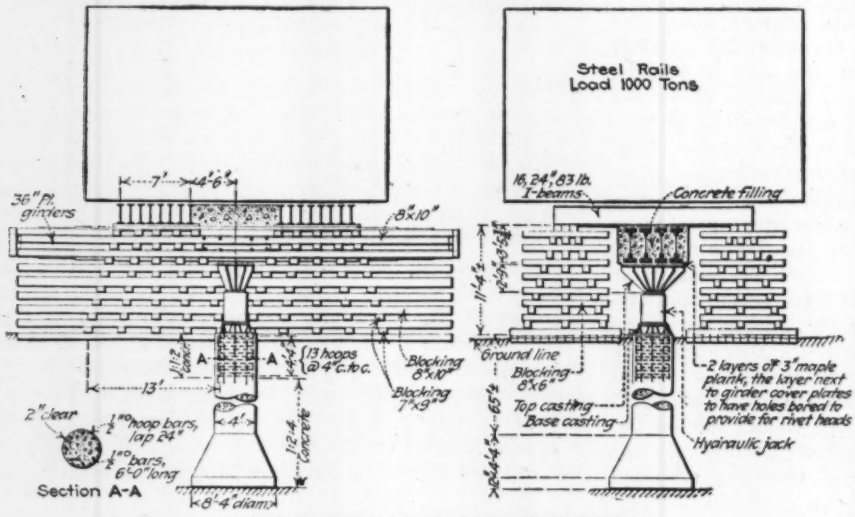
The Chicago building code prescribes no specific loading for hardpan, and the building commissioner can specify such load limits as he considers desirable. It is usual, however, to allow about 6 tons per square foot in foundation designs. The foundation piers already built for the headhouse were designed for a four-story structure, on the basis of a foundation pressure of 6 tons per square foot. As it is now proposed to build a 16-story structure, it was considered desirable to determine what load could be safely imposed on the present piers and what additional piers will be required.

For this purpose it was decided to conduct tests on two of the completed piers, resting on the hardpan. These piers had been built in open wells in accordance with usual Chicago practice; they are of concrete and are 4 ft. in diameter, one cylindrical throughout and the other belled out at the bottom to a base diameter of 8 ft. 4 in. For the main part of the piers the concrete is a 1:2:4 mix made with crushed limestone, and was spouted into the open well, with no tamping in place. at the top a 1 : 1 : 2 mix was used, reinforced by bars and hooping, as shown.

A 1,000-ton hydraulic jack built specially for these tests is about 31 in. in diameter and 37 in. high, with a 21-in. plunger having a stroke of 10 in. This will be seated on a casting like a column shoe on the top of the pier and upon it will be another casting to bear against the reaction girders. For the resistance or reaction loading of the jack there will be a pair of 3-ft. plate girders 44½ ft. long (selected from material for one of the viaducts at the station) these girders being supported at the ends on timber blocking. Across the ends

of the girders will be groups of I-beams and upon these will be piled steel rails weighing over 1,000 tons.

With this loading in place, any desired load on the pier can be applied by means of the jack. Inspection chambers may be dug at the base of the straight pier to enable observations to be made as to progressive results. A maximum load can be reached equivalent to 20 tons per square foot at the base of the belled pier and 80 tons at that of the straight pier, not allowing for the skin friction of the concrete pier (in 70-ft. of wood-lined shaft). This skin friction is estimated to be at least 400 lb. per square foot, amounting to 175 tons on the 70-ft. pier and reducing the total load on the base by this amount.



LOADING TEST ON FOUNDATION PIER

Earlier tests on the Chicago hardpan have been made by loading areas 12 x 12-in. at the bottom of the open wells for the piers. Such tests have shown ¼-in. settlement under 24,200 lb. after 44 hr. and under 30,000 lb. after 60 hr. In another case, a 24,200-lb. load caused ½-in. settlement in 33 hr., the unit load adopted for the foundation piers in that case being 13,300 lb. per square foot on the hardpan. Direct loading of an experimental pier 5 ft. in diameter and 10 ft. deep, belled out at the bottom, was tried in foundation tests for the Michigan Central R. R. station at Detroit (*Engineering News*, March 6, 1913, p. 460, and Oct. 1, 1914, p. 704).

The present Chicago tests were planned under the direction of J. d'Esposito, chief engineer and A. J. Hammond, assistant chief engineer, Chicago Union Station Co.

Irrigation and Drainage in Nebraska

By the 1920 census, 1 per cent of the farm land of Nebraska is irrigated. There are 3,021 irrigated farms aggregating 442,690 acres. This is 73 per cent more acreage than in 1910. Nearly 120,000 acres more were capable of being irrigated. The capital invested in the area capable of being irrigated was $24.73, and the average cost per acre for operation and maintenance was $1.48, an increase of 39c. over 1910 costs. Drains have been installed on 10,793 acres of irrigated lands, but are needed on 365,725 acres. The average quantity of irrigation water entering the canals was 4.2 acre-ft. per acre, but only 2.4 acre-ft. per acre was delivered to the ground.

Resurvey of the Southern Railway After Improvement

One Party on 675 Miles in Five Months Surveyed Distance, Alignment and Structures and Set Mile-Post Marks

By Geo. W. White
Civil Engineer, Charlotte, N. C.

CHANGES in mileage on the Southern Ry., having been introduced by numerous revisions of alignment in connection with the double tracking of the 637-mile main line between Washington, D. C., and Atlanta, Ga., it became necessary to establish the correct locations of the mile posts. On the completion of the improvement work, therefore, it was decided to make a continuous remeasurement of the entire line, as part of a complete resurvey for a continuous map and profile, since the records of grades, curves and structures were incomplete.

A resurvey party which started on June 20, 1919, completed its work on Nov. 19, losing about twelve days on account of rain. Progress averaged 5.2 miles per day, exclusive of Sundays, for 675 miles of main line and spurs. This party consisted of an assistant engineer in charge, transitman, levelman, two chainmen, three rodmen, an axeman and a cook. Camp cars were furnished and the party lived along the line, keeping the cars reasonably near the work. The stops averaged three or four days, except in a few cases when they extended to a week or ten days. Movements of the cars were determined by the local train service, the trains being used extensively in going to and from work.

A zero point was established at the Union Station in Washington. Measurement and alignment were taken on the right hand rail of the northbound track, and levels were taken on the low rail of this track. In this way the party was facing traffic most of the time. Slightly greater accuracy would have been obtained by taking the center line between tracks, but it was thought that this would not justify the additional time required to stake out this center line. The error from this cause at any point was small, as each curve in one direction counteracts a similar amount of curvature in the opposite. Where the two main tracks are not parallel, a new northbound or southbound track having been built on a different location, both lines were surveyed. Sections of the old line still in use for local work were also surveyed.

The chainmen went ahead, measuring pluses to all structures, main line switch points, road crossings and existing mile posts, and also marking the correct location of mile posts. Buildings on the right-of-way were located, their size and distance from the center line being measured. Culverts were measured and pluses taken to abutments and piers of bridges. Reliance was placed on existing maps for right-of-way, yard and ter-

minal improvements, and for structures not adjacent to the main line in cities. The assistant engineer usually accompanied the chainmen and took notes of all the information developed by them, as this practice increased both speed and efficiency of the party, but when this was not possible, the transitman took these notes. It would have been well worth the additional expense to have had a topographer for this purpose.

The transit party followed, taking deflections around all curves and taking readings at 100-ft. intervals. At each set-up the vernier was set at zero; thus the total angle for each curve was the sum of deflections to transit points. Curves were not run to intersections, as this would have required too much time. The entire line was referred to true north by observations taken on Polaris at each degree of longitude or oftener. Calculated bearings were carried from one observation point to the next without correction for convergence of meridians, but the error in bearings due to this cause was not more than about 30 minutes for these distances.

Levels were based on sea level datum, using government bench marks near the line. Where there was an error of more than a few hundredths of a foot the levels were corrected to this new elevation. If the discrepancy was large it was distributed back over a distance of 10 to 40 miles. The latter distance was used only once, at the end of the longest run without a check reading, this being from Springfield to Motley, Va., 189 miles. The error at Motley, as compared with government elevations, was only 0.69 ft. Bench marks were established at intervals of two to eight miles, one being placed at or near every station, usually one between stations and two or more in cities. They were marked by crosses chiseled in permanent masonry structures.

Painting all stations on the rail for future reference was the duty of the axeman. He also cut and drove large stakes to mark the new location of mile posts, besides painting the mile post number and station on the rail. Several mile post locations were on bridges and viaducts, two on station platforms, one in a tunnel and one on the headwall of a 50-ft. arch.

This resurvey showed the total distance to be 637.6 miles, or 10.2 miles less than the distance by the original line. All mile posts have been moved to their correct locations, and the numbers of stations, bridges and block signals have been changed to correspond. On Jan. 1, 1921, revised tariffs were put into effect.

Maps in 20-mile sections were plotted to a scale of ½-mile to 1 in., with a profile on the same sheet and a record of bench marks. All information was given that could be shown on such a small scale, but no attempt was made to show right-of-way. Blueprints of these sheets, bound together by divisions, make a ready reference map of the entire line. Complete maps on a scale of 400 ft. to 1 in. and in 4-mile sections show all information developed on the survey and also yards, terminals and right-of-way.

The survey was made under the supervision of E. M. Durham, Jr., and H. Stringfellow, then chief engineer of construction and district engineer respectively. The writer was assistant engineer in charge of the party.

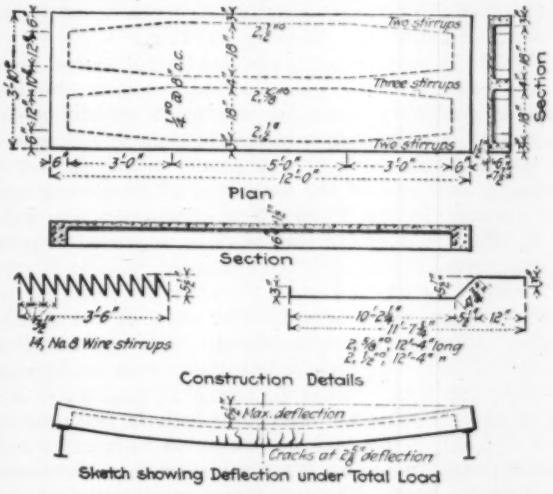
All Construction Work Under City Engineer

All engineering and construction work carried on by the City of San Antonio, Tex., is put under the city engineer by an ordinance recently adopted by the city commission. D. D. Harrigan is now city engineer.

Light Weight Aggregate Economical in Concrete Building

Tests Show Concrete With Burnt Shale Aggregate Stronger Than With Stone and Its Use Effects Saving

DURING the war great interest was taken in the use in the government concrete ships of a light weight aggregate made by burning and crushing certain kinds of shale or clay, and hopes were frequently expressed that there are great possibilities in the material for ordinary structures, where its low weight would reduce dead load, and thus effect savings enough to offset the added cost of the aggregate. Little has been heard of the material in this use, however, though some of the aggregate has been produced commercially since the war. In Kansas City, Mo., the Haydite Co., successor to the American Aggregate Co. has been manufacturing the material in the form which it calls Haydite and has been selling it for use in commercial structures. George E. McIntyre, architectural engineer, of Kansas City, has been studying the use of the aggregate and has brought to the attention of *Engineering News-Record* certain observations of his in regard to it.



DETAILS OF TEST PANELS FOR COMPARING STRENGTH OF ARTIFICIAL CLAY AGGREGATE AND STONE AND SAND AGGREGATE IN CONCRETE

The general history and properties of the light weight aggregate were described in an article in *Engineering News-Record* April 24, 1919, p. 802, and was described there as follows:

"The new light weight aggregate is an artificially burned clay or shale uniformly filled with small, non-connecting coils. Speaking non-technically, it is in bloated brick; that is, the basic clay or shale from which it is formed, when subjected to a temperature of about 1,800° to 2,000° in a kiln, becomes plastic and seared over on the surface, a coating being formed there which retains the gases generated by decomposition, under heat, of the contained compounds. This expanding gas blows the brick or the clay ball full of holes and bloats it to several times its original size."

The article then describes a number of methods of making the aggregate and recites some of the tests on concrete mixed with it, this concrete, however, be-

ing a very rich (1:2/3:4/3) mixture used in the concrete ships. It states also that there is a company in Kansas City under the direction of Stephen J. Hayde which is manufacturing a somewhat similar product to the government aggregate, which product is known as Haydite. This was developed some years before as the aggregate for sand-lime-brick and is produced in a vertical kiln. The government's aggregate, accord- to the figures given in 1919, would test as high as 5,000 lb. in the rich ship concrete and made a concrete weighing around 115 lb.

Mr. McIntyre states that his attention was called to Haydite about a year ago, when he was designing a twelve-story reinforced-concrete building. The manufacturers desired to have it used on the building, but owing to the fact that it was an unfamiliar material to the engineer and that there were little data available at that time regarding its merits he did not feel justified in permitting its use. It interested him so, however, that he conducted several experiments with it and has been continuing his investigations in regard to the strength of the concrete made from it and to its economic relations to concrete building.

Haydite as made today is crushed to the desired sizes at the manufacturing plant and is taken to the job already graded to meet the engineer's requirements, so that it is only necessary to add cement and water in the mixer to form a high grade, uniformly dense concrete, and none of the difficulties of pre-proportioning common in the Middle West aggregates are present. For ordinary building work it is graded to pass a ¾-in. sieve.

Strength tests have been conducted simultaneously on a Haydite and stone concrete test panel of the details shown in the accompanying sketch. For this test two panels of joist and slab construction were made side by side, one with crushed limestone as aggregate, the other with Haydite as aggregate, both in the proportion of 1:6. Equal care was taken in both cases and test cylinders made at the time showed a high-class concrete for both. The test pieces were tested at the ages of 28 and 90 days by the Kansas City Testing Laboratory with the results shown herewith:

	Stone Concrete	Haydite
Crushing strength at 28 days (lb./sq. in.)	1,558	1,814
Crushing strength at 90 days (lb./sq. in.)	2,208	2,460
Weight per cubic foot (lb.)	150	106

For loading the panels a wooden bin was constructed so that the material contained therein rested directly on the slab. The sides were tapered toward the top slightly so as to do away with frictional resistance. Material for loading was crusher screenings weighing 95 lb. per cubic foot. Deflections were measured by a copper wire stretched under the center joists. Provision was made for a total load of 700 lb. per square foot as calculations showed that the ultimate strength of the concrete should be exceeded before reaching this figure.

The Haydite panel was loaded first and when the bin was full showed a deflection of ½ in. and four face cracks along the under side of the middle joist. Since facilities were not then available for increasing the load, it decided to unload the panel to test the one made of stone concrete. When the load was removed the panel recovered its original position and the cracks closed so tightly as not to be noticed by the naked eye. The calculated stress in the concrete was 2,300 lb. per square inch. Loading was then commenced on the stone concrete panel. When the total load reached 650 lb. per square foot the panel failed in compression, at that time having a total deflection of 2¼ in. Calculations showed a stress of 2,180 lb. per square inch in the concrete.

Seven months after the Haydite panel was made it was again set up and loaded until it failed. This time it failed in compression under a total load of 960 lb. per square foot, which would give a calculated stress of 3,075 lb. per square inch.

Following this crude though informing test, Mr. McIntyre instituted a series of investigations of Haydite and stone concrete cylinders, to be broken at seven days, twenty-eight days, three months, six months, and one year. These results are not yet available for report. A test of the fireproofing properties of the concrete shows that samples heated 1,500 to 1,800° F. for 5 hr. and then allowed to cool give an ultimate strength of 1,337 lb. per square inch as compared with the original strength of 2,835 lb. per square inch. Similar samples of stone concrete placed in the same furnace crumpled before they were removed.

So much for the test investigations that have been made. The economic study was principally concerned with the design of a roof over a gymnasium addition at the Westport High School of Kansas City. It had been decided to raise the roof of an existing gymnasium to build a second floor for the use of another gymnasium. The room was 51 x 96 ft. in plan and is spanned by four plate girders 19.3 in. c. to c. which carried the concrete floor of ribbed slab construction. The structural members were designed for a live load of 100 lb. per square foot and a dead load based on stone concrete of 150 lb. per cubic foot. Working drawings were prepared and a contract made on this basis. Drawings were then prepared by Mr. McIntyre using the same live load but using Haydite concrete at 106 lb. per cubic foot instead of the usual stone concrete. In both cases a maximum compressive stress of 750 lb. per square inch was used. The quantities of the materials necessary for the work according to the two designs and their costs are given in the following itemized analysis comparing the use of the two materials:

	Original Design (Stone Concrete)	Alternate Design (Haydite Aggregate)
Structural steel	66,401 lb.	54,783 lb.
Reinforcing steel	13,140 lb.	12,840 lb.
Concrete	120 cu.yd.	97 cu.yd.
For the structural and reinforcing steel the savings were as follows:		
Structural steel	11,618 lb. at 3.88c.	$450.00
Reinforcing steel	300 lb. at 3.5c.	10.50
Concrete in the original design required the following:		
Cement	175 bbl. at $2.80	$490.00
Stone	120 cu.yd. at 2.75	330.00
Sand	60 cu.yd. at 2.75	165.00
Labor	120 cu.yd. at 3.00 per yd.	360.00
Total		$1,345.00
Concrete in the re-design required the following:		
Cement	141.5 bbl. at $2.80	$396.20
Haydite	116.5 cu.yd. at 6.00	699.00
Labor	97 cu.yd. at 2.75 per yd.	267.00
Total		$1,362.00
Excess cost of Haydite concrete		$17.00
Saving on steel		460.50
Total net saving—$460.50—$17.00		443.50

The floor area covered including the locker room over one bay is 6,138 sq.ft., making a saving of approximately 7¼c. per square foot. Mr. McIntyre says he has allowed 25c. per cubic yard less for labor in handling the Haydite, and that he regards this as extremely conservative as the material is delivered to the job in proper grading and only one set of wheelers is required, as it is so much lighter it is more easily

shoveled than stone aggregate, so that to his mind, at least, a greater saving may result. In the above comparison he used the figures given by the contractor.

It will be noticed that the cost of the artificial burnt clay aggregate is $6 a cubic yard as against $2.75 per cubic yard for the stone and sand.

Wayne County Widens Old Concrete Highways

Original Roads Less Than 16 Ft. To Be Increased to a Minimum of 20 Ft.—Construction Methods Described

CONSTRUCTION has begun, widening all concrete highways in Wayne County, Michigan, which are now less than 18 ft. wide. Ultimately all of these narrow roads will be enlarged to 20 ft. or, when on main routes, to 22 or 24 ft. This year two 12-ft. roads are being widened to 20 ft. by a 4-ft. strip on each side. One, known as Fort Road, was constructed in 1911-12 and the other known as Eureka Road, 12 miles long, was built in 1910, 1912 and 1914. Neither road, even in its old parts, requires resurfacing or reconstruction

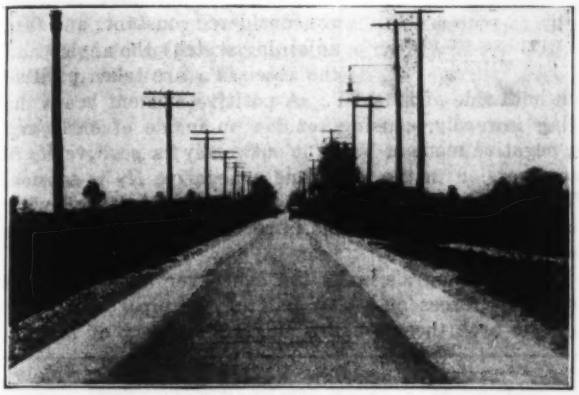


FIG. 1. TWO 4-FT. SIDE SLABS WIDEN 12-FT. ROAD TO 20 FT.

in any other particular, as is indicated by Fig. 1, to conform in smoothness to the new construction.

One side strip is constructed at a time so that about 9 ft. of the old pavement and one shoulder are free to carry traffic during construction. This is particularly necessary as traffic is intense and to detour it would be expensive both to the county in providing the detour and to the vehicle users in increased mileage and reduced speed. No practicable saving in cost of construction, which might be obtainable by building the side strips simultaneously, it was considered could make up for the loss to traffic by closing the road. Wayne County roads, with Detroit as their focus, have a traffic of 3,000 to 10,000 vehicles a day.

FIG. 2. TRACTION GRADER OUTFIT PREPARES SUB-GRADE FOR SIDE SLAB

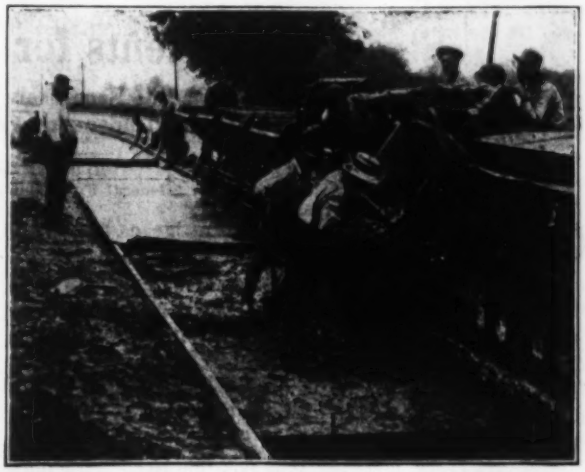


FIG. 3. SIDE SLAB CONSTRUCTED AS MINIATURE ROAD

Construction is begun by plowing the shoulder for the necessary width and removing the earth by means of a blade grader hauled by a tractor. The plowing is also done by the tractor. A trench deep enough for a 9-in. slab is excavated whatever the edge thickness of the old slab may be. Its bottom is smoothed, an outside form is set, and the edge of the old slab is broken down by sledging so as to give the break a rough undercut as shown by Fig. 3. With the sub-grade prepared, the method of constructing the slab is similar to that of standard section road construction.

A ½-cu.yd. portable mixer is set up once every 2 miles as a central mixing plant, and the mixed concrete is hauled a mile each way by industrial railway and deposited as indicated by Fig. 3. The joints are placed opposite the joints in the old slab and the concrete is finished by strike board and belt. Materials for the mixer are brought in by motor trucks and the mixer is charged by wheelbarrow. With a 12-car train about 900 ft. of 4-ft. slab has been placed in a day. The cost of the slab has averaged about $3.50 a square yard.

Construction in Wayne County is by force account and the road widening is being conducted by county forces under the direction of the county road commission, Edward N. Hines, chairman, Detroit, Mich.

Certification of Steamship Water Supplies

Since April 15 the general scheme of supervision of water supplies used for drinking and cooking purposes on railway trains engaged in interstate commerce has been extended to supplies on board ships on rivers and lakes and between ports of the United States and adjacent countries. Ship water supplies must either be obtained on shore from an approved source or else must be treated on shipboard by an approved method. No connections will be permitted between drinking water pipes and pipes for any other water system. The Public Health Service expresses the hope that by means of this control outbreaks of typhoid fever and dysentery, such as occurred twice on river steamers in 1920, will be prevented.

Stress Coefficients for Large Horizontal Pipes

Various Elementary Kinds of Loading Separately Considered and Adaptable by Proper Combination to Actual Loadings Under Any Condition of Support and Surcharge

By James M. Paris
General Fireproofing Co., San Francisco

CALCULATIONS of stresses in large horizontal pipes are tedious and liable to error when the full analysis must be gone through anew for each case of loading. Under these conditions it is rarely practicable to determine the comparative merits of different arrangements of the support or of the surcharge, and it is likely even in an important undertaking that a design of pipe-line may be adopted that is unnecessarily costly. When loadings are split up into their several elementary cases, however, it is possible to compute once for all the formulas for bending moment and tension in the shell, and reduce the labor required in any specific example to mere numerical computation for the formulas, using a proper combination of the elementary loadings to suit the actual loading in the example.

This method is developed in the present article, and is made still more adaptable to the needs of practice by stress-coefficient tables computed for the several elementary loadings. The application of the tables is illustrated by examples.

General Principles of Analysis

For balanced loads on a large circular pipe, the tangents at the ends of the vertical diameter which bisects the loads do not change direction. The deflection along this diameter may be assumed to take place at one end. Considering the half pipe to one side of this diameter, its one end may be assumed fixed, and the half pipe treated as a cantilever beam; the free end may be imagined to deflect under the applied external loads, and then brought back to its original direction by a moment M_T applied there, and back to its original position by a horizontal force H_T. No force is required along the vertical diameter at the free end, as the pipe is free to deflect vertically there. But a force equal to the vertical component of the loads is put at the bottom to prevent translation of the ring.

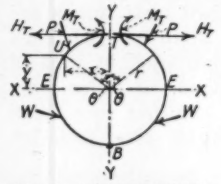


FIG. 1. FORCE CONDITIONS IN PIPE SHELL

In this problem the modulus of elasticity, E, and the moment of inertia of the pipe shell, I, are considered constant; and (see adjoining sketch) the angle θ and the abscissa x are taken positive on both side of axis YY. A positive moment bends the ring inwardly, causing tension on inside of shell, and a negative moment bends it outwardly; a positive H_T is compression in the shell, and a negative H_T is tension. These forces act as shown if the results of the following equations are positive, and in reversed sense for negative answers.

In the integrals, m is the cantilever moment of the external forces on either half of the pipe. From the elastic arch theory, using Maxwell's theory of recipro-

$$H_T = -\frac{P}{\pi}\sin^2\phi$$
$$M_T = Pr\left[\frac{\sin^2\phi}{\pi} + \frac{1}{\pi} - \frac{(\pi-\phi)}{\pi}\sin\phi + \frac{\cos\phi}{\pi}\right]$$
$$M_E = M_T + Pr\sin\phi - Pr - \frac{Pr\sin^2\phi}{\pi}$$
$$M_B = M_T + Pr\sin\phi - \frac{2Pr\sin^2\phi}{\pi}$$

Case 1

CASE I. CONCENTRATED LOADS ON TOP

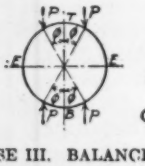
ϕ	0°	15°	30°	45°	60°	75°	90°	Coeff. of
H_T	0	−0.021	−0.079	−0.159	−0.239	−0.297	−0.318	P
M_T	+0.637	0.410	0.257	0.172	0.139	0.134	0.137	Pr
M_E	−0.363	−0.353	−0.323	−0.280	−0.235	−0.197	−1.082	Pr
M_B	+0.637	0.626	0.598	0.561	0.527	0.506	0.500	Pr

$$H_T = +\frac{P}{\pi}\sin^2\phi$$
$$M_T = Pr\left[-\frac{\sin^2\phi}{\pi} + \frac{(\pi-\phi)}{\pi}\sin\phi - \frac{\cos\phi}{\pi} - \frac{1}{\pi}\right]$$
$$M_E = M_T + \frac{Pr\sin^2\phi}{\pi}$$
$$M_B = M_T - Pr\sin\phi + \frac{2Pr\sin^2\phi}{\pi}$$

Case 2.

CASE II. CONCENTRATED LOADS ON BOTTOM

ϕ	180°	165°	150°	135°	120°	105°	90°	Coeff. of
H_T	0	+0.021	0.079	0.159	0.239	0.297	0.318	P
M_T	0	−0.011	−0.038	−0.075	−0.109	−0.130	−0.137	Pr
M_E	0	+0.011	0.042	0.084	0.129	0.166	0.182	Pr
M_B	0	−0.229	−0.379	−0.464	−0.498	−0.502	−0.500	Pr

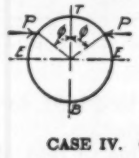


$$H_T = 0 \quad M_T = M_B = Pr\left(\frac{2\cos\phi}{\pi} - \frac{(\pi-2\phi)}{\pi}\sin\phi\right)$$
$$M_E = M_T - Pr(1-\sin\phi)$$

Case 3

CASE III. BALANCED CONCENTRATED LOADS ON TOP AND BOTTOM

ϕ	0°	15°	30°	45°	60°	75°	90°	Coeff. of
M_T	+0.637	0.399	0.219	0.097	0.030	0.004	0	Pr
M_E	−0.363	−0.342	−0.281	−0.196	−0.104	−0.030	0	Pr
M_B	+0.637	0.399	0.219	0.097	0.030	0.004	0	Pr



$$H_T = P\left[\frac{\sin\phi\cos\phi}{\pi} + \frac{(\pi-\phi)}{\pi}\right]$$
$$M_T = Pr\left[-\frac{\sin\phi\cos\phi}{\pi} - \frac{(\pi-\phi)}{\pi} + \frac{(\pi-\phi)\cos\phi}{\pi} + \frac{\sin\phi}{\pi}\right]$$
$$M_E = M_T + rH_T - \left[Pr\cos\phi\right]_0^{\phi}$$
$$M_B = M_T + 2rH_T - Pr(1+\cos\phi)$$

Case 4

CASE IV. CONCENTRATED HORIZONTAL LOADS

ϕ	0°	15°	30°	45°	60°	75°	90°
H_T	+1.00	0.996	0.971	0.909	0.804	0.663	0.500
M_T	0	−0.028	−0.090	−0.154	−0.196	−0.215	−0.182
M_E	0	+0.002	0.015	0.048	0.109	0.199	0.318
M_B	0	−0.002	−0.014	−0.043	−0.086	−0.137	−0.182

ϕ	105°	120°	135°	150°	165°	180°	Coeff. of
H_T	0.337	0.196	0.091	0.029	0.004	0	P
M_T	−0.138	−0.086	−0.042	−0.014	−0.002	0	Pr
M_E	0.199	0.109	0.048	0.015	0.002	0	Pr
M_B	−0.205	−0.195	−0.154	−0.090	−0.019	0	Pr

$$H_T = P\frac{(\pi-\phi)}{\pi}\sin\phi$$
$$M_T = Pr\left[\frac{1}{\pi} + \frac{\cos\phi}{\pi} - \frac{(\pi-\phi)}{\pi}\sin\phi\right]$$
$$M_E = Pr\left[\frac{\cos\phi}{\pi} + \frac{1}{\pi} - \frac{(\cos\phi)}{\pi}\right]$$
$$M_B = Pr\left[\frac{\cos\phi}{\pi} + \frac{1}{\pi} + \frac{(\pi-\phi)}{\pi}\sin\phi - \sin\phi\right]$$

$2P\cos\phi$

Case 5

CASE V. CONCENTRATED RADIAL INWARD LOADS

ϕ	0	15°	30°	45°	60°	75°	90°
H_T	0	+0.237	0.417	0.530	0.577	0.563	0.500
M_T	+0.637	+0.388	+0.177	+0.013	−0.100	−0.163	−0.182
M_E	−0.363	−0.330	−0.272	−0.164	−0.023	+0.141	+0.318
M_B	+0.637	+0.604	+0.511	+0.366	+0.188	−0.002	−0.182

ϕ	105°	120°	135°	150°	165°	180°	Coeff. of
H_T	0.402	0.289	0.177	0.083	0.021	0	P
M_T	−0.167	−0.129	−0.084	−0.041	−0.011	0	Pr
M_E	+0.235	+0.160	+0.093	+0.042	+0.010	0	Pr
M_B	−0.329	−0.417	−0.437	−0.375	−0.228	0	Pr

cal deflections, the following equations for the unknown reactions M and H are easily deduced:

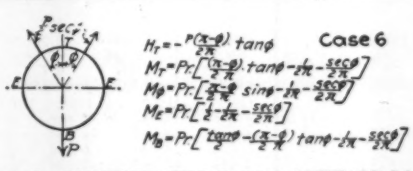
$$H_T = \frac{\int_o^\pi m\cdot ds \int_o^\pi (r-y)ds - \int_o^\pi m(r-y)ds \int_o^\pi ds}{\int_o^\pi (r-y)^2 ds \int_o^\pi ds - \left[\int_o^\pi (r-y)ds\right]^2} = \frac{2}{\pi r}\int_o^\pi m\cdot\cos\theta\cdot d\theta$$

$$M_T = \frac{\int_o^\pi m\,(r-y)ds \int_o^\pi (r-y)ds - \int_o^\pi m\cdot ds \int_o^\pi (r-y)^2 ds}{\int_o^\pi (r-y)^2 ds \int_o^\pi ds - \left[\int_o^\pi (r-y)ds\right]^2} = -rH_T - \frac{1}{\pi}\int_o^\pi m\cdot d\theta$$

The shell moment at any point U is, $M^\theta = M_T + H_T r\,(1 - \cos\theta) + M\theta$, where m is the moment of loads between T and U around U.

By substituting for m in these integrals its actual value for any loading, values of H_T, M_T, M_E, M_B, are found for that loading. When this has been done for various simple or elementary loadings, as in the present article, any number of these loadings may be combined, and by addition of the separate values the resultant value of H_T or M_T may be found.

Cases 7 to 15 may be used in combinations for earth loading according to the judgment of the engineer. For example, Cases 16, 18 and 8 acting together give $2w_s r \sin\phi = \pi r^2 w_{13} + 2\pi r w_{16}$, and this gives $w_s = \pi(\frac{1}{2} r w_{13} + w_{16})/\sin\phi$, which is the value to be used in Case 8. For $\phi = 7\frac{1}{2}°$, $H_T = 0.0002 r w_s - 0.5 r w_{16} - 1.25\, r^2 w_{13}$.



$H_T = -\frac{P(\pi-\phi)}{2\pi}\tan\phi$

$M_T = Pr\left[\frac{(\pi-\phi)}{2\pi}\tan\phi - \frac{1}{2\pi} - \frac{\sec\phi}{2\pi}\right]$

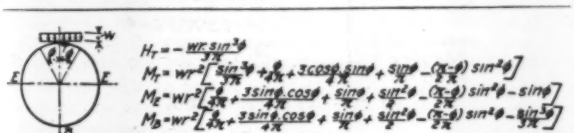
$M_\phi = Pr\left[\frac{\pi-\phi}{2\pi}\sin\phi - \frac{1}{2\pi} - \frac{\sec\phi}{2\pi}\right]$

$M_E = Pr\left[\frac{1}{2} - \frac{1}{2\pi} - \frac{\sec\phi}{2\pi}\right]$

$M_B = Pr\left[\frac{\tan\phi}{2} - \frac{(\pi-\phi)}{2\pi}\tan\phi - \frac{1}{2\pi} - \frac{\sec\phi}{2\pi}\right]$

CASE VI. CONCENTRATED RADIAL OUTWARD LOADS

ϕ	0	15°	30°	45°	60°	75°	Coeff. of
HT	0	—0.123	—0.241	—0.375	—0.577	—1.089	P
MT	—0.318	—0.211	—0.102	—0.009	+0.100	+0.315	Pr
ME	+0.182	+0.176	+0.157	+0.116	+0.023	—0.274	Pr
MB	—0.318	—0.313	—0.295	—0.259	—0.189	+0.003	Pr
Mϕ	—0.318	—0.205	—0.135	—0.119	—0.189	—0.492	Pr



$H_T = -\frac{wr\sin^3\phi}{3\pi}$

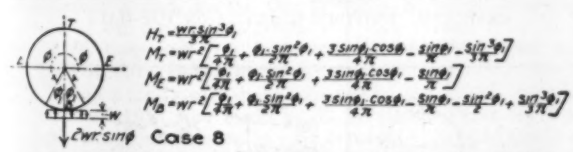
$M_T = wr^2\left[\frac{\sin^3\phi}{3\pi} + \frac{\phi}{2\pi} + \frac{3\cos\phi\sin\phi}{4\pi} + \frac{\sin\phi}{\pi} - \frac{(\pi-\phi)\sin^2\phi}{2\pi}\right]$

$M_E = wr^2\left[\frac{\phi}{4\pi} + \frac{3\sin\phi\cos\phi}{4\pi} + \frac{\sin\phi}{\pi} + \frac{\sin^2\phi}{2} - \frac{(\pi-\phi)\sin^2\phi}{2\pi} - \sin\phi\right]$

$M_B = wr^2\left[\frac{\phi}{4\pi} + \frac{3\sin\phi\cos\phi}{4\pi} + \frac{\sin\phi}{\pi} + \frac{\sin^2\phi}{2} - \frac{(\pi-\phi)\sin^2\phi}{2\pi} - \frac{\sin^3\phi}{3\pi}\right]$

CASE VII. UNIFORMLY DISTRIBUTED LOAD ON TOP

ϕ	7½°	15°	30°	45°	60°	75°	90°	Coeff. of
HT	—0.0002	—0.002	—0.013	—0.037	—0.069	—0.096	—0.106	wr
MT	+0.085	0.134	0.213	0.257	0.281	0.295	0.299	wr²
ME	—0.047	—0.093	—0.175	—0.238	—0.279	—0.300	—0.307	wr²
MB	+0.084	0.164	0.312	0.432	0.518	0.570	0.587	wr²



$H_T = \frac{wr\sin^3\phi_1}{3\pi}$

$M_T = wr^2\left[\frac{\phi_1}{4\pi} + \frac{\phi_1\sin^2\phi_1}{2\pi} + \frac{3\sin\phi_1\cos\phi_1}{4\pi} - \frac{\sin\phi_1}{\pi} - \frac{\sin^3\phi_1}{3\pi}\right]$

$M_E = wr^2\left[\frac{\phi_1}{4\pi} + \frac{\phi_1\sin^2\phi_1}{2\pi} + \frac{3\sin\phi_1\cos\phi_1}{4\pi} - \frac{\sin\phi_1}{\pi}\right]$

$M_B = wr^2\left[\frac{\phi_1}{4\pi} + \frac{\phi_1\sin^2\phi_1}{2\pi} + \frac{3\sin\phi_1\cos\phi_1}{4\pi} - \frac{\sin\phi_1}{\pi} - \frac{\sin^2\phi_1}{2} + \frac{\sin^3\phi_1}{3\pi}\right]$

CASE VIII. UNIFORMLY DISTRIBUTED LOAD ON BOTTOM

ϕ_1	7½°	15°	30°	45°	60°	75°	90°	Coeff. of
HT	+0.0002	0.002	0.013	0.037	0.069	0.096	0.106	wr
MT	—0.0001	—0.001	—0.006	—0.018	—0.033	—0.045	—0.049	wr²
ME	+0.0001	0.001	0.007	0.019	0.036	0.051	0.057	wr²
MB	—0.0081	—0.031	—0.105	—0.193	—0.270	—0.320	—0.337	wr²

It will be observed that by supporting the pipe under all conditions of loading by a single reaction at the bottom, one is able to use several types of loading together. It is only necessary to equate the sum of their reactions to zero, as the upward reactions of one or more types must balance the downward reactions of the others. Thus, if a pipe is supported by a uniform upward reaction over part of the bottom (Case 8), and loaded by two concentrated loads on top (Case 1), R_s must be equal and opposite to R_1, or $2w_s r \sin\phi = 2P_1$, so that $w_s = P_1/r\sin\phi$. Using the table of Case 8 with this value of w, the values of H_{T_1}, M_{T_1}, M_{E_1} and M_{B_1} are taken out, and added to H_{T_1}, M_{T_1}, M_{E_1} and M_{B_1} respectively. The sums are the required values.

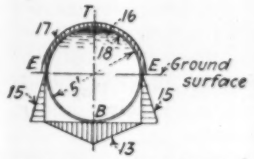


FIG. 2. COMBINATION LOADING I

This method will be applied to two examples, in which five types of loading occur in combination.

EXAMPLE I—A 60-in. steel pipe with ½-in. shell is half buried in slightly yielding ground, and covered with 8 in. of earth. The pipe is full of water. Earth is taken at 105 lb. per cu.ft., and horizontal earth pressure at one-third the vertical pressure. The reaction is computed thus:

Shell (Case 16)	321 lb. per lin.ft.
Water (Case 18)	1223 lb. per lin.ft.
Earth cover (Case 17)	550 lb. per lin.ft.
Horizontal earth pressure (Case 15)	0 lb. per lin.ft.
Vertical reaction (Case 13), total of above	2094 lb. per lin.ft.

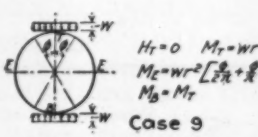
Since the total reaction in Case 13 is wr^2 per lineal foot, $2094 = wr^2$ or $w_{13} = 335$ lb. The results are as follows:

COMBINATION LOADING I

Case	HT Lb. per Ft. Run	HT Lb. per In. Run	MT Ft.-lb. per ft. run (=in.-lb. per in. run)
16	$-0.5000 w_{16} r$	—25.5	— 2.1	$+0.500 w_{16} r^2$	+ 64
18	$-0.750 w_{18} r^2$	—292.1	—24.3	$+0.250 w_{18} r^2$	+242
17	$-0.250 w_{17} r$	— 43.7	— 3.6	$+0.387 w_{17} r^2$	+170
15	$+0.0625 w_{15} r^2$	+ 13.7	+ 1.1	$-0.027 w_{15} r^2$	— 15
13	$+0.0265 w_{13} r^2$	+ 55.5	+ 4.6	$-0.013 w_{13} r^2$	— 67
	Total = —24.3 lb. per in. run (tens.)			Total	+394

Case	ME Ft.-lb. per ft. run (-in.-lb. per in run)	MB Ft.-lb. per ft. run (= in.-lb. per in. run)
16	$-0.571 w_{16} r^2$	— 73	$+1.50 w_{16} r^2$	+191
18	$-0.285 w_{18} r^2$	—278	$+0.75 w_{18} r^2$	+731
17	$-0.434 w_{17} r^2$	—190	$+0.887 w_{17} r^2$	+388
15	$+0.035 w_{15} r^2$	+ 19	$-0.069 w_{15} r^2$	— 38
13	$+0.014 w_{13} r^2$	72	$-0.126 w_{13} r^2$	—660
	Total	—450	Total	+612

As the ½-in. plate has a section modulus of $\frac{1}{12}$ per inch run, the bending stress at T is 9,450 lb. per sq.in. (pipe bends in), that at E is 10,800 lb. per sq.in. (pipe bends out), and that at B is 14,700 lb. per sq.in. (pipe bends in).



$H_T = 0$ $\quad M_T = wr^2\left[\frac{\phi}{2\pi} + \frac{\phi\sin^2\phi}{2\pi} + \frac{3\sin\phi\cos\phi}{2\pi} - \frac{\sin^2\phi}{2}\right]$

$M_E = wr^2\left[\frac{\phi}{2\pi} + \frac{\phi\sin^2\phi}{2\pi} + \frac{3\sin\phi\cos\phi}{2\pi} - \sin\phi\right]$

$M_B = M_T$

CASE IX. BALANCED UNIFORMLY DISTRIBUTED LOADS, TOP AND BOTTOM

ϕ	7½°	15°	30°	45°	60°	75°	90°	Coeff. of
MT = MB	+0.085	0.133	0.207	0.239	0.248	0.249	0.250	wr²
ME	—0.047	—0.092	—0.168	—0.219	—0.243	—0.249	—0.250	wr²

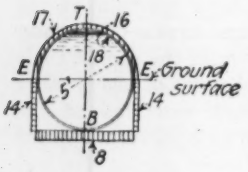


FIG. 3. COMBINATION LOADING II

EXAMPLE II—For the same pipe as in the preceding example, but in very firm ground, allowing the bottom reaction (and the lateral earth loading) to be taken uniform, the calculation is as follows: Vertical reaction same as before, 2,094 lb.; $w_s = R_s/2r =$ 419 lb. Taking values for Cases 16, 18, 17 from the table given for Example I, and those for Cases 14, 8 from the coefficient tables for those cases, the figures become:

COMBINATION LOADING II

Case	H_T Lb. per Ft., Run	M_T Lb. per In., Run	M_T Ft.-lb. per ft. run (= in.-lb. per in. run)
14 $+0.212w_{14}r$	+17.5	+1.5	$-0.087w_{14}r^2$ — 19
8 $+0.106w_8r$	+111.0	+9.2	$-0.049w_8r^2$ —128
Total	−30.0	+10.7, (tension) −19.3	Total, +476 − 147, +329

Case	M_E Ft.-lb. ft. run (= in.-lb. per in. run)	M_B Ft.-lb. per ft. run (= in.-lb. per in. run)
14	$+0.125w_{14}r^2$ +27	$-0.163w_{14}r^2$ — 36
8	$+0.057w_8r^2$ +159	$-0.337w_8r^2$ —880
Total,	−541, +186, −355	Total, +1,310 −916, +394

The flexural stresses due to these moments are: at T, 7,900 lb. per sq.in. (pipe bends in); at E, 8,520 lb. per sq.in. (pipe bends out); at B, 9,460 lb. per sq.in. (pipe bends in). The stresses are more uniform and less in amount than those of the first example, as might be expected.

$H_T = -wr(\frac{\pi}{2} - \frac{\sin^3\phi}{3})$

$M_T = wr^2[\frac{\pi}{2} - \frac{\sin^3\phi}{3} - \frac{(\pi+2\phi)}{8} - \frac{3\sin\phi\cos\phi}{4\pi} + \frac{(\pi-\phi)}{2\pi}\sin^2\phi - \frac{\sin\phi}{\pi}]$

$M_E = M_T + rH_T - wr^2(\frac{1}{2} - \sin\phi + \frac{\sin^2\phi}{2})$

$M_B = M_T + 2rH_T + wr^2(\frac{1}{2} - \frac{\sin^2\phi}{2})$

Case 10

CASE X. UNIFORMLY DISTRIBUTED PARTIAL LOADING

ϕ	0°	7½°	15°	30°	45°	60°	75°	90°	Coeff. of
H_T	−0.106	−0.106	−0.104	−0.093	−0.069	−0.037	−0.010	0	wr^3
M_T	+0.299	0.210	0.165	0.087	0.052	0.018	0.004	0	wr^2
M_E	−0.307	−0.273	−0.216	−0.131	−0.059	−0.028	−0.007	0	wr^2
M_B	+0.587	0.490	0.423	0.276	0.165	0.069	0.016	0	wr^2

$H_T = -\frac{wr^2}{4}$

$M_T = wr^2[\frac{3}{36\pi} - \frac{1}{6}]$

$M_E = M_T + rH_T + \frac{wr^3}{6}$

$M_B = M_T + 2rH_T + \frac{wr^3}{3}$

Case 11

CASE XI. WEDGE-SHAPED LOADING, ZERO AT CROWN

$H_T = -0.0796\,wr^2$; $M_T = +0.1074\,wr^3$; $M_E = -0.1388\,wr^3$; $M_B = +0.2816\,wr^3$

$H_T = -\frac{wr^2}{12\pi}$

$M_T = wr^3[\frac{17}{36\pi} + \frac{1}{24}]$

$M_E = M_T + rH_T - \frac{wr^3}{3}$

$M_B = M_T + 2rH_T + \frac{wr^3}{6}$

Case 12

CASE XII. WEDGE-SHAPED LOADING, ZERO AT HAUNCHES

$H_T = -0.0265\,wr^2$; $M_T = +0.1920wr^3$; $M_E = -0.1679\,wr^3$; $M_B = +0.3056wr^3$

$H_T = +\frac{wr^2}{12\pi}$

$M_T = wr^3[\frac{5}{24} - \frac{25}{36\pi}]$

$M_E = M_T + rH_T$

$M_B = M_T + 2rH_T - \frac{wr^3}{6}$

Case 13

CASE XIII. WEDGE-SHAPED BOTTOM LOADING

$H_T = +0.0265\,wr^2$; $M_T = +0.0127\,wr^3$; $M_E = +0.0138wr^3$; $M_B = -0.1263wr^3$

$H_T = wr[\frac{(\pi-\phi)}{\pi}\cos\phi + \frac{2\sin\phi}{3\pi} + \frac{\sin\phi\cdot\cos^2\phi}{3\pi}]$

$M_T = wr^2[\frac{(\pi-\phi)\cos\phi}{\pi} - \frac{2\sin\phi}{3\pi} - \frac{\sin\phi\cos^2\phi}{3\pi} + \frac{(\pi-\phi)\cdot\cos^2\phi}{2\pi} + \frac{3\cos\phi\cdot\sin\phi}{4\pi} + \frac{(\pi-\phi)}{4\pi}]$

$M_E = wr^2[\frac{(\pi-\phi)\cdot\cos^2\phi}{2\pi} + \frac{3\cos\phi\cdot\sin\phi}{4\pi} + \frac{(\pi-\phi)}{4\pi} - [\frac{\cos^2\phi}{2}]_0^{\frac{\pi}{2}}]$

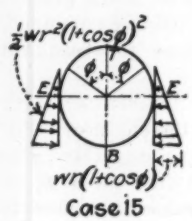
$M_B = wr^2[\frac{(\pi-\phi)\cdot\cos\phi}{\pi} + \frac{2\sin\phi}{3\pi} + \frac{\sin\phi\cdot\cos^2\phi}{3\pi} + \frac{(\pi-\phi)\cdot\cos^2\phi}{2\pi} + \frac{3\sin\phi\cdot\cos\phi}{4\pi} + \frac{(\pi-\phi)}{4\pi}\frac{1}{2} - \cos\phi - \frac{\cos^2\phi}{2}]$

Case 14

CASE XIV. UNIFORM HORIZONTAL LOADING

ϕ	0°	15°	30°	45°	60°	75°	90°
H_T	+1.000	0.966	0.868	0.718	0.540	0.363	0.212
M_T	−0.250	−0.249	−0.244	−0.214	−0.187	−0.138	−0.087
M_E	+0.250	0.250	0.249	0.244	0.228	0.192	0.125
M_B	−0.250	−0.250	−0.249	−0.245	−0.232	−0.205	−0.163

ϕ	105°	120°	135°	150°	165°	180°	Coeff. of
H_T	0.104	0.040	0.011	0.002	0.000	0	wr
M_T	−0.045	−0.019	−0.005	−0.001	−0.000	0	wr^2
M_E	0.059	0.022	0.006	0.001	0.000	0	wr^2
M_B	−0.112	−0.063	−0.027	−0.008	−0.001	0	wr^2



$H_T = wr^2[\frac{\cos^3\phi\cdot\sin\phi}{12\pi} + \frac{13\cdot\cos\phi\cdot\sin\phi}{24\pi} + \frac{(\pi-\phi)}{2\pi}\cos^2\phi + \frac{(\pi-\phi)}{8\pi}]$

$M_T = wr^3[\frac{(\pi-\phi)\cdot\cos^3\phi}{6\pi} - \frac{\sin\phi\cos^3\phi}{12\pi} - \frac{(\pi-\phi)}{2\pi}\cos^2\phi + \frac{11\cos^2\phi\cdot\sin\phi}{36\pi} - \frac{13\cos\phi\cdot\sin\phi}{24\pi} + \frac{(\pi-\phi)\cos\phi}{4\pi} + \frac{\sin\phi}{9\pi} - \frac{(\pi-\phi)}{8\pi}]$

$M_E = M_T + rH_T - [\frac{wr^3\cos^3\phi}{6}]_0^{\frac{\pi}{2}}$

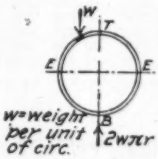
$M_B = M_T + 2rH_T - \frac{wr^3}{6}(1+\cos\phi)^3$

Case 15

CASE XV. WEDGE-SHAPED HORIZONTAL LOADING

θ	0°	15°	30°	45°	60°	75°
H_T	+0.625	0.592	0.500	0.374	0.244	0.136
M_T	−0.208	−0.199	−0.174	−0.138	−0.095	−0.056
M_E	+0.250	0.243	0.219	0.177	0.128	0.077
M_B	−0.292	−0.281	−0.256	−0.219	−0.169	−0.117

θ	90°	105°	120°	135°	150°	180°	Coeff. of
H_T	0.062	0.022	0.006	0.001	0.000	0	wr^2
M_T	−0.027	−0.010	−0.003	−0.000	0.000	0	wr^2
M_E	0.035	0.012	0.003	0.001	0.000	0	wr^2
M_B	−0.069	−0.033	−0.012	−0.001	−0.000	0	wr^2



$H_T = -\frac{wr}{2}$

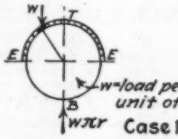
$M_T = +\frac{wr^2}{2}$

$M_E = -0.5708\,wr^2$

$M_B = 1.50\,wr^2$

Case 16

CASE XVI. WEIGHT OF PIPE



$H_T = -0.250wr$

$M_T = +0.3866\,wr^2$

$M_E = -0.4342\,wr^2$

$M_B = +0.8866\,wr^2$

Case 17

CASE XVII. UNIFORM BLANKET ON TOP HALF

$H_T = -\frac{3wr^2}{4}$ $H_B = -\frac{5}{4}wr^2$

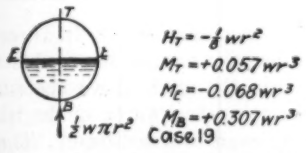
$M_T = +\frac{wr^3}{4}$

$M_E = -0.2854\,wr^3$

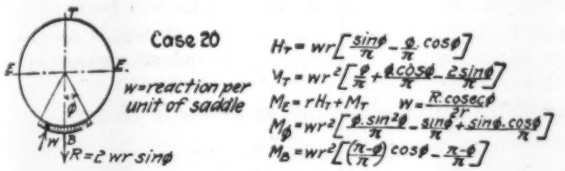
$M_B = +\frac{3}{4}wr^3$

Case 18

CASE XVIII. PIPE FULL OF WATER



CASE XIX. PIPE HALF FULL OF WATER


T
E
E
Case 20
w=reaction per unit of saddle
R=2 wr sinφ
$H_T = wr\left[\frac{\sin\phi}{\pi} - \frac{\phi}{\pi}\cos\phi\right]$
$M_T = wr^2\left[\frac{\phi}{\pi} + \frac{4\cos\phi}{\pi} - \frac{2\sin\phi}{\pi}\right]$
$M_E = rH_T + M_T \quad w = \frac{R\cdot\operatorname{cosec}\phi}{2r}$
$M_\phi = wr^2\left[\frac{\phi\cdot\sin^2\phi}{\pi} - \frac{\sin^2\phi}{\pi} + \frac{\sin\phi\cdot\cos\phi}{\pi}\right]$
$M_B = wr^2\left[\left(\frac{\pi-\phi}{\pi}\right)\cos\phi - \frac{\pi-\phi}{\pi}\right]$

CASE XX. UNIFORM RADIAL SADDLE REACTION

ϕ	7½°	15°	30°	45°	60°	75°	90°
H_T	0.0002 +4	0.0018	0.0148	0.0483	0.1090	0.1995	0.3183
MT	−0.00012	−0.0009	−0.0072	−0.0234	−0.0514	−0.0902	−0.1366
ME	+0.00012	0.0009	0.0076	0.0149	0.0576	0.1093	0.1817
M	−0.00820	−0.0313	−0.1116	− 0.2197	−0.3333	−0.4324	−0.5000

Tastes and Odors in Water Due to Low Oxygen Content

Maumee River Investigations Indicate Water in Ice-Bound Channel Subject to Anaerobic Bacterial Decomposition

DISAGREEABLE tastes and odors in the winter in the water taken from the Maumee River for domestic consumption at Toledo, Napoleon and Defiance, Ohio, have several times in past years been so pronounced as to cause severe complaints by consumers as well as loss of fish life. In 1920 the complaints of the water purveyed in Toledo and Napoleon became so general that the State Department of Health was induced to make an investigation to determine, if possible, the cause as well as to recommend remedial measures. In a report made to W. H. Dittoe, chief engineer of the board, by F. H. Waring, assistant engineer, the conclusion is reached that the trouble is due to lowered dissolved oxygen content brought about by a long continued ice layer. The following notes are from this report:

The water of the Maumee River is naturally hard and contains an abnormally high chlorine content (NaCl), probably due to the gas- and oil-well wastes which are discharged into the smaller tributaries in and around Findlay and Lima. There is not sufficient salt in the river water, however, to cause any inconvenience. In addition to the oil- and gas-well wastes mentioned, the river receives sewage pollution from a large number of communities aggregating more than 15,000 in population along the banks of the Maumee and its tributaries.

All of the eleven communities within 180 miles, with the exception of St. Mary's, which has a treatment plant, discharge sanitary sewage untreated into Maumee River. At a point about five miles below Defiance, the state has constructed a dam across the Maumee River to divert a portion of the flow to the Miami and Erie Canal. The dam is 400 ft. long and 7 ft. high and causes slack water as far upstream as Defiance.

A detailed study of the disturbance to the Toledo supply in 1912 and 1913 was made by R. Winthrop Pratt for the department of public service. He concluded that the trouble was due to coal-tar wastes entering the Maumee River not far below the water-works intake. The wastes were carried upstream under certain conditions of wind and slack water currents past the intake to the filter plant. The removal of these wastes to a point farther downstream eliminated the source of complaint.

During the winter of 1916 and 1917 a very marked reoccurrence of tastes and odors exhibited itself in the Toledo public water supply. The department of public service employed George W. Fuller, J. W. Ellms and W. G. Clark as consultants to advise the city regarding the source and possible means for overcoming the objectionable conditions. In a conference with the chief engineer of the State Department of Health, the conclusion was reached that the tastes and odors were due to the growth and subsequent decay of vegetation on the river bed and banks, taking place at a time when the river was low and continuously ice-bound for a long period. The engineers recommended that the city attempt to remove the objectionable gaseous constituents by aeration and the dissolved constituents by more complete coagulation with sulphate of alumina. No action was taken, however, to provide the aeration recommended.

Fish Life Destroyed

The State Fish and Game Commission had received notification from its several deputy wardens in the Maumee River watershed that a serious condition to fish life was observed during the winter of 1919-1920. As far as could be learned the conditions this year were much more injurious to fish life than have ever been noted in the past.

Investigations made in 1920, when there was 2 ft. of ice on the river and during the breaking up of the ice, indicate as low as 35 per cent saturation before and 65 per cent after the break-up. At Toledo the figures were 58 and 82 per cent respectively. The odors, which were strong grassy, and tastes, were most objectionable when the dissolved oxygen was lowest. Only one sample had a faint tarry odor.

During the period of these investigations, information was secured from the State Department of Health of Michigan that a similar condition prevailed throughout that state for those public water supplies that were obtained from surface sources. Dissolved oxygen studies on streams frozen over indicated that on streams receiving no pollution of industrial or municipal character whatever, the dissolved oxygen reached as low as 40 per cent saturation. Some streams exhibited as low as 4 per cent saturation when influenced by sewage and other wastes.

As far as could be determined in this survey in Ohio in 1920, the one river of size tributary to the Maumee River which receives no pollution of an industrial or municipal character, namely, the Tiffin River, showed equally as low a dissolved oxygen factor as the other points examined. It is not possible to state how greatly the industrial wastes and municipal sewage affected the dissolved oxygen and oxygen demand factors, and a more extended study would be necessary to reach such a conclusion. Nevertheless, it is felt that sufficient data are at hand to make the following general conclusions:

The winter just past has been severe and prolonged for an unusual period, extending from very early in December to almost the middle of March. Stream flow in the Maumee River has been at a minimum continuously; in fact as low as can be remembered by the older inhabitants in the vicinity. The dissolved oxygen reached a point low enough to endanger the life of fish seriously. Concentration of organic materials in the river water coming from vegetative sources natural to the watershed, and coming from industrial and municipal wastes, made heavy demand upon the oxygen in the water, such that decomposition took place largely under anaerobic conditions. Ice-bound conditions unbroken over the entire period favored the anaerobic decomposition.

Analytical evidence indicates that the sources of the tastes and odors are the products of such anaerobic decomposition of organic matter. The opinions advanced in 1917 by the consulting engineers employed by the city of Toledo would seem to be confirmed and a satisfactory relief for similar conditions in the future would consist of aeration of the public water supplies, in conjunction with proper coagulation in the water treatment processes, so as to remove objectionable gaseous constituents by aeration and the dissolved constitutents by coagulation.

Drainage Reclamation of Alkaline Irrigated Lands

Ditch and Tile Drains Remove Alkali and Excess Water from Land in Utah at Reasonable Cost—Old Drains Utilized

By Charles F. Brown
Consulting Engineer, Salt Lake City, Utah

DRAINAGE of irrigated lands which have become waterlogged and alkaline through excessive application of water is an increasingly necessary supplement to irrigation projects. An example of the successful reclamation of such lands is afforded by Millard County Drainage District No. 1, near Hinckley, Utah, which comprises 5,040 acres in the Escalante Valley and is irrigated by the Deseret Irrigation Co.'s gravity canal from the Sevier River.

With an abundant water-supply, various portions of the land have been successively waterlogged, made alkaline and abandoned, sometimes returning after many years of temporary productiveness even without drainage. Such land responds rapidly to drainage and requires but a short time for reclamation, the cost per acre being small in relation to the ultimate productivity and value of the land so treated. Mistakes of design and construction in some tile drainage work had tended to give the impression that these lands could not be drained and reclaimed successfully.

The most important problems with which the pioneer drainage engineers and contractors were confronted were as follows: (1) Caring for running sands in such a way that the water could be drained into the tiles without a flow of sand to cause stoppage of the drains; (2) securing within economical cost a filter medium which would accomplish the objects of drainage with permanency and durability of operation; (3) control of irrigation water so as to prevent damage to the newly filled trenches and the consequent menace of washing out or displacing the tiles; (4) salvaging earlier works on which from $40,000 to $75,000 had been spent upon drains which were damaged by sand and erosion and were inefficient owing to the use of small tiles and especially long tile lines of small sizes.

Soil Treatment—Construction Methods

Although the trouble was due in part to the use of 3 to 4 acre-feet of irrigation water per season on lands that should not have been given more than 2½ acre-feet, alkali would form on the most carefully irrigated lands without artificial under-drainage. It has been demonstrated on similar lands that even if there is no surplus of water applied in irrigation, so that the groundwater table is not raised and the water can be disposed of entirely through the plants and from the surface of evaporation, there will still follow accumulations of alkaline salts within the surface foot of soil, thus preventing the growth of crops.

Land in this district is sandy clay loam of high quality, but much of it has deteriorated and was suitable only for pasturage when the drainage district was formed. Other portions threatened to fall into a similar condition.

The first construction was 1¼ miles of open ditch 8 to 10 ft. wide on the bottom, with side slopes of 1 on 1½ for the firmer portions and 1 on 2 where the soil was less stable. The depths ranged from 3½ at the Sevier River outlet to a maximum of 12 ft. through a slight ridge. These dimensions made it possible to discharge the tile drains into the ditch above the surface of the water, thus preventing backwater in the tiles with possible clogging by sand and sediment. The open ditch is calculated to carry 15 sec.-ft. To protect it from the accumulation of weeds and other debris a wire mesh fence on each side of the spoil banks will be hung on iron posts, permitting the burning of weeds as they are blown across the fields and lodged against the fences. This ditch of approximately 80,000 cu.yd. was completed with one dragline excavator in 15 days.

Tile Drain Layout

Work was then started on the laying of 224,000 lin.ft. of 6 to 15-in. tile, about 58,000 ft. of the largest size being laid in several parallel lines affording both field drainage and outlet drains. All tiles have their tops approximately 5 ft. below the ground and the laterals drain into the main tiles at the top, again preventing backwater. Drains are from 400 to 1,000 ft. apart, depending upon the degree of waterlogging and the character of the soil. One trenching machine with a crew of seven men had laid as high as 40,000 ft. of tile a month, and the average daily output per machine from Oct. 1 to June 1 was 1,000 ft. This is rapid work, especially as 60 per cent of the tiling had cinders from a sugar factory packed around the joints.

This type of construction is used in all quicksand pockets and in sandy lands, wet or dry, the cinders operating as a filter to strain out the sand. A shield and tile laying apparatus attached the trenching machine enabled this packing to be placed around the joints at a cost of less than 1c. per foot. The machine also had an attachment which provides an end thrust of several hundred pounds on the tile until the cinders and partial back-filling are in place, thus overcoming the tendency of the tiles to "creep" behind the machine and leave wide joints through which the earth might enter. In soft ground the tiles were laid on 1-in. boards 8 in. wide, breaking joints with the tile.

When water is first applied to the newly filled trenches or onto the lands in irrigation, a thin iron sheet is fitted between the tile joints at intervals of 600 ft. to cause backwater and consequent saturation until the filling is thoroughly puddled and settled. This is removed after the irrigation supply has been cut off and the roughly filled trenches have settled compactly down to the level of the surrounding lands so that no subsequent erosion would occur due to ordinary irrigation.

Sand Traps Installed

Sand traps 3 x 6 ft. with bottoms 18 in. below the bottom of the tiles and open to the surface were installed where required. These are of wood, but will serve as forms for future concrete boxes. These sand traps are specially frequent at junctions with old tiling which it was sought to salvage. In the earliest stages of the salvaging these traps had to be emptied of sand twice daily, but the necessity is much less frequent when flushing the old lines had ceased.

Spring crops have been grown on lands which a year ago were white with alkali. The efficiency of the system is indicated by the fact that the 15-in. tiles are running full while irrigation is in progress and about half full when the section drained is not being irrigated. Cross-connecting drains have been installed to

distribute any excess flow of one line during irrigation to other lines not so heavily loaded.

About $15,000 worth of the former ineffective work has been salvaged by adapting new plans to old and by the use of sand traps wherever water could make its way through the old drains. More than half of the old drains will be put back into service, but in some cases it has been necessary to build new tile drains around sections that have been completely clogged. Benefits were assessed at an average of about $100 an acre. The total cost of old and new work will average $48 an acre.

The writer's direction of the work began in February, 1920, but he had been engaged previously on surveys and investigations. Three separate contracts were let: open ditch, D. A. Foley Construction Co.; manufacturing the concrete tile on the ground, J. T. Corbridge, Salt Lake City; laying the tile drains, Baer Drainage Co., Ogden, Utah.

Strength of Concrete at Increasing Intervals After Mixing

By Ross C. Durst
Assistant Professor of Civil Engineering, Municipal University of Akron, Ohio

THE tables below show the results of an experiment performed in the regular laboratory testing classes in the University of Akron, Ohio. Eight parties made tests which are averaged in the tables. The object was to determine the loss in strength caused by using concrete which had been allowed to stand for some time before using. The tests were performed with 1 : 3 mortars, using a variety of brands of cement.

TABLE I. STRENGTH OF CONCRETE MOLDED AT INCREASING INTERVALS AFTER MIXING

(Lb. per Sq.In.)

Time After Mix	Av. Tens.	Av. Comp.	Per Cent of Normal Tension	Per Cent of Normal Comp.
Normal	383	2,396	100.00	100.00
1 hour	338	2,410	88.2	100.6
2 hours	336	2,367	87.9	98.7
3 hours	323	2,019	84.3	84.3
4 hours	299	2,228	78.0	92.9
5 hours	269	1,508	70.2	62.9
6 hours	235	1,392	61.4	58.1
7 hours	208	1,401	54.3	58.5
8 hours	168	1,108	43.9	46.2
9 hours	111	555	28.9	22.9

In the experiments in Table I the entire mass was thoroughly mixed, using normal consistency. At intervals of one hour, just sufficient material for molding a sample was cut off and molded, leaving balance of

TABLE II. STRENGTH OF CONCRETE REMIXED AT INTERVALS OF ONE HOUR

(Lb. per Sq.In.)

Time After Mix	Av. Tens	Av. Comp.	Per Cent of Normal Tens.	Per Cent of Normal Comp.
Normal	348	2,014	100.00	100.00
1 hour	328	2,238	94.25	111.1
2 hours	335	2,253	96.26	111.8
3 hours	322	2,162	92.53	107.3
4 hours	291	1,945	83.6	96.6
5 hours	289	1,794	83.0	89.7
6 hours	205	1,324	58.9	65.7
7 hours	192	1,135	55.2	56.3
8 hours	179	1,013	51.4	50.3
9 hours	145	565	41.7	28.0

mass undisturbed. In the experiments of Table II the same procedure was followed except the entire mass was remixed at intervals of one hour. The experiment given in Table III was performed very carefully by two seniors using ½ hour intervals. They also ran a third test adding a small amount of water each time.

TEST III. STRENGTH OF CONCRETE AT INTERVALS OF ONE-HALF HOUR

(Lb. per Sq.In.)

Time of Making	Remixed Tens.	Remixed Comp.	Unmixed Tens.	Unmixed Comp.	Tempered Tens.	Tempered Comp.
Normal	315	2,700	347	3,680	268	3,017
½ hour	341	2,767	335	3,217	287	2,822
1 hour	355	3,590	362	3,818	322	2,797
1½ hours	387	3,325	366	4,090	310	3,085
2 hours	432	3,577	370	4,037	222	3,230
2½ hours	420	3,427	360	3,900	320	3,212
3 hours	349	3,370	372	3,830	306	2,895
3½ hours	382	2,870	397	3,520	312	3,075
4 hours	316	2,840	367	3,837	334	3,577
4½ hours	324	3,012	347	3,085	287	3,287
5 hours	346	2,712	315	2,935	332	3,617
5½ hours	312	2,835	302	2,335	364	3,355
6 hours	203	1,948	243	2,257	325	3,740
6½ hours	233	2,075	277	2,255	341	3,610
7 hours	170	1,742	235	2,170	358	3,312
7½ hours	207	1,360	201	1,477	387	3,250
8 hours	121	800	156	1,510	320	3,585
8½ hours	228	1,540	214	1,902	326	4,207

Three briquettes made from Pile No. 1, and immediately immersed in water gave the following test:

Tension	Comp.	
153	1,425	Average tension of 168 lb. and compression of 1,472 lb.,
214	2,037	which shows that the immersion in water did not help to
137	955	increase the strength.

As shown by the last column of Table III there was a slight but continuous increase in strength showing a greater strength at the end of 8½ hours than at the beginning. No sweeping conclusions can be drawn from these results. They seem to indicate that very little strength is ever lost up to the third or fourth hour while in practically every case there is an increase in strength at the end of the first hour.

Concrete Bridge Floor Replaced by Wood

REPLACEMENT of the concrete floor of an important highway bridge in Indiana by wood is now in progress, under direction of the State Highway Commission. The structure crosses the White River at Bloomfield, and has three spans, two of 142 ft. and one of 300 ft. c. to c. end pins. It has a 16-ft. roadway. Its concrete floor has been giving frequent trouble from heavy trucks breaking through, and repair work has been found difficult, according to William J. Titus, bridge engineer.

A strength survey and investigation of the old structure indicated that substitution of a wood floor for the concrete floor would not only do away with the present maintenance difficulties, but would make it possible to increase the live-load capacity of the structure (with respect to the strength of the floor members) from about 10 tons to 15 tons. Accordingly a contract was awarded to E. C. Wright, of Bloomfield, for removing the old floor and putting in a creosoted wood-block floor, at a price of $9,370.86. The new floor consists of 3-in. blocks in 1-in. diagonal sheathing on 3-in. transverse subplanking on nailing strips bolted to the I-beam stringers. All the timber is creosoted.

The concrete floor now being removed is not believed to be the original one. It is thought probable that the spans were originally built with timber floor, and the concrete floor was applied later; this belief is supported by the fact that the concrete floor was very thin, which may be attributable to the fact that when the substitution was made the trusses were found not strong enough to permit of placing a heavier concrete floor. Apparently, also, the concrete was injured by freezing at the time of laying. Mr. Titus says, "There is nothing about the transaction which would indicate that a properly designed and placed concrete floor can by any possibility be destroyed by abrasion by traffic. All of our new steel bridges are being constructed with concrete floors, with a 1½-in. monolithic wearing surface.

Washington Building Reconstruction—Columns of Lower Story Replaced by Girders

Modernization of an Early New York Office-Building Involves Difficult Operation—40-Ton Girders in Pairs at Second Floor Carry Weight of Eight Stories, Transferred From Columns by Wedging

By T. Kennard Thomson
Consulting Engineer, New York City

IN THE EARLY eighties one of the old New York Schuyler family sold his residence at No. 1 Broadway, which was then torn down and the big and imposing (for those days) Washington Building was erected on the site. This building was recently bought by the International Mercantile Marine Co. Having long since lost its imposing appearance, due to the dingy brick exterior and hopelessly dark entrance halls and the like, it needed renovating badly. So the new owners retained Walter B. Chambers, architect, to turn the dismal old building into a modern office structure of the very highest class. Mr. Chambers' artistic genius has succeeded in transforming an eyesore (Fig. 1) into a really beautiful edifice (Fig. 2). The accomplishment of this feat involved some very interesting engineering problems, which were successfully solved by ingenious design and construction methods.

FIGS. 1 AND 2. WASHINGTON BUILDING BEFORE AND AFTER RECONSTRUCTION

The building has a frontage on Broadway of 96 ft. 1½ in., on Battery Place of 171 ft. 6¾ in., and on Greenwich St. of 103 ft. 11½ in. Rearranging its lower floors into steamship booking offices was one of the main structural elements of the work.

In order to obtain a steerage booking office in the basement, and a first and second class booking office on the ground floor, an entire row of eight columns (and two others, or ten in all) was removed, producing two rooms clear of columns for the full width from the Battery Place wall to the court wall on the whole length of the building from Broadway to Greenwich St. The columns were removed for three stories in height, which enabled the old floor on the Broadway level to be taken out and replaced by a new floor, about a foot higher than the old, and the old second floor to be removed entirely, together with the columns immediately above and below it.

This makes the old third floor the new second floor. It makes the steerage booking office a room 40 x 100 ft., 15 ft. high, and the first and second class booking office a room 40 x 160 ft., 24 ft. high. These booking offices in addition to their artistic merit will have the great advantage of large windows on three sides. The light and natural ventilation thereby secured make decided contrast with the old Washington Building.

The first operation in the reconstruction was shoring up the window openings and stripping the red brick and brownstone facing from the entire surface of the three fronts, replacing it with a beautiful Indiana limestone. Care was taken to strip only one-half of the old brick piers at a time, so as to avoid endangering the safety by cutting off too much at once. Owing to the pressure of time and the necessity of arranging with the tenants so as to cause them the least possible incon-

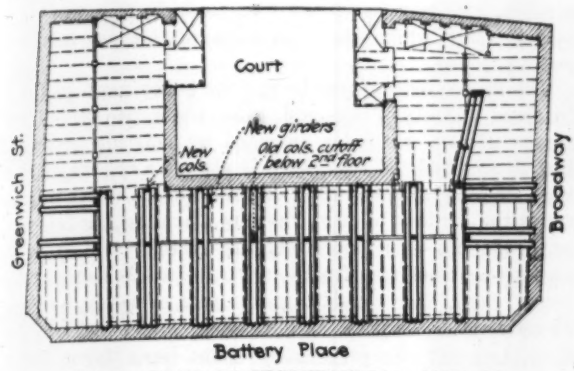


FIG. 3. PLAN OF SECOND FLOOR GIRDERS

Middle columns in first story removed after eight-story load was transferred to girders.

venience, it was necessary to place the outside ashlar work before tackling the ticklish job of removing the three tiers of columns from under the eleven stories above.

Fortunately, the old building was founded for the most part on bedrock. And to be safe beyond a doubt—safety first was the keynote of this work—it was decided to put reinforced-concrete distributing girders, as shown in the sectional drawing, Fig. 4, under the column bases. These girders are spread at the middle to pass on either side of the middle columns, which were to be removed later.

It should be stated here that the old building is of wall-bearing construction. The outside walls consist of heavy brick piers between the various window openings, and the floors are supported by these walls in conjunction with interior cast-iron columns. If one had judged solely by the cross-sectional area of the old brick piers and the high grade of the brickwork, which had been laid up in good cement mortar (very unusual in those days), he would not have hesitated to strip the old work for the new ashlar without elaborate precautions such as the shoring shown in the view, Fig. 7; but examination showed that the apparent factor of safety had been very largely reduced by chimney and other flues as well as numerous vertical chases or recesses for pipes, etc. For this reason one of the first steps was to wash out the soot and dirt of the flues and other openings as found, and fill them with concrete.

To carry the ground-floor framing on a clear span between walls, new girders were inserted, each being

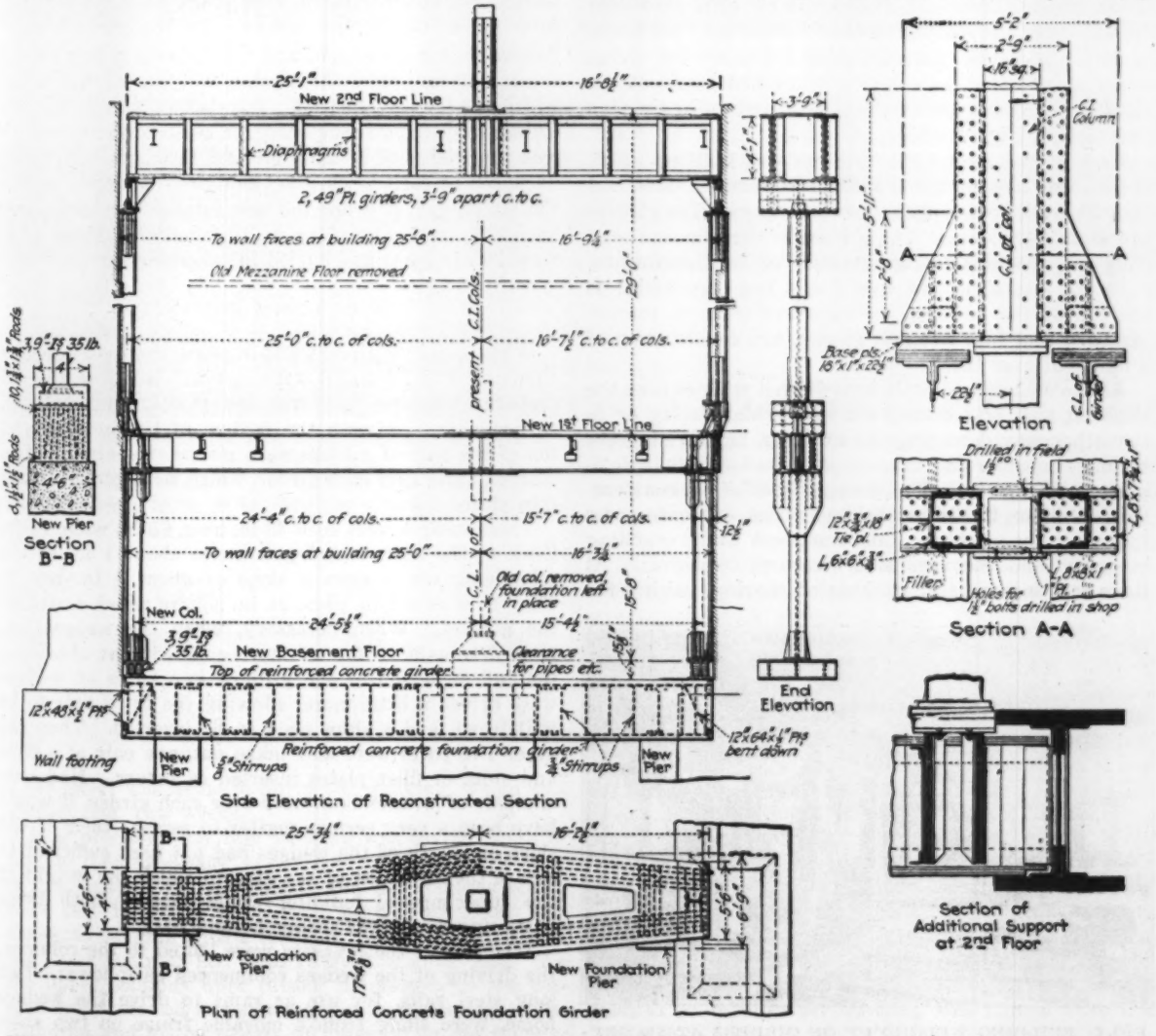


FIG. 4. NEW STRUCTURAL SYSTEM IN FIRST STORY; COLUMN BRACKETS FOR TRANSFERRING LOAD TO GIRDERS

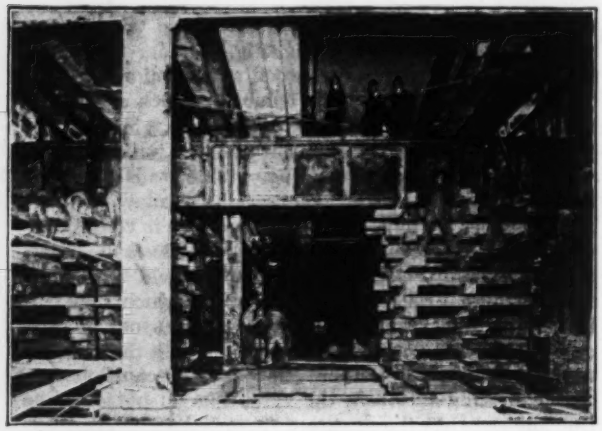


FIG. 5. HALF OF DOUBLE GIRDER BEING RAISED
Two chain blocks hung from wooden trusses traveling on second floor were used to lift the 40-ton load. Cribbing was placed to follow up the lift.

double so as to pass around the center column, which was later removed. They consisted of two 28-in. I-beams of 180 lb. per lin.ft. On top of the ends of these girders were set steel columns with cantilever tops to carry the main girders of the second-floor framing. These latter were designed to carry the eleven floors above after the columns below had been cut out their arrangement and proportions are given by the plan and section, Figs. 3 and 4.

Each of the second-floor girders was built up of 48 x ⅜-in. web plate, a two 8 x 6 x 1-in. flange angles, and four 21 x ⅞-in. cover plates for each flange. The girders are 41 ft. 9½ in. long. The girders at the east and west ends are of special design because of local conditions.

In the meantime, two new floors had been added to the top of the building by transformation of the old mansard roof into two new stories, and construction of a new roof over these.

As the owners and architects did not wish to take the slightest risk of cracking the new ashlar facing or in any other way damaging the building, or alarming the tenants, considerable expense was incurred to accomplish these results. The company's chief of construction, William F. Gibbs, held a series of conferences including the architect, his engineers and consulting engineer, and the various contractors concerned. At these meetings several methods of shoring, raising the girders, etc., were considered by the help of a working model, after which the plan subsequently carried out was approved.

FIG. 6. BUILDING WEDGED UP ON GIRDERS AT SECOND-FLOOR LEVEL

The first intention was to roll the heavy main girders in from Battery Place and raise them two floors by means of two gin poles operated by hoisting engines. But it was realized that there is always a chance of the rope slipping, or some other slight accident, which might cause the girders to drop, thereby alarming the tenants or producing even more serious results. So it was decided to build two frames or travelers to run on the second floor, each consisting of a pair of heavy wooden Howe trusses, long enough to span one panel of the floor, and lift the girders by chain hung from these travelers. The travelers were set on rollers, so that after one girder had been lifted they could be rolled to the next panel. After being rolled into position, a bent of 12 x 12 timbers resting on the basement floor was placed under each of the travelers to avoid straining the old floor system.

Each pair of trusses carried a 25-ton differential chain block. To make assurance doubly sure, as the girders were lifted a timber-crib blocking was built up near each end as fast as the girder was lifted, so that even if the hoisting tackle slipped the girders could not drop more than a few inches. As the girders were hoisted to the old second and third floors, a few beams were removed until the girder had passed up, after which they were replaced. But before doing this, an elaborate system of temporary wooden shores and struts was inserted, and in addition two 1¼-in. tie rods were anchored in each brick pier, and run diagonally across the building, just below the new second-floor level, very effectively tying the four walls together. These rods were left in place and buried in concrete.

Wedges Under Brackets

When a pair of girders was in place, the steel brackets shown in Figs. 4 and 6 were securely bolted to the old cast-iron columns just over the girders by 32 1¼-in. turned-bolts. Between the bottom of the bracket and top of the pair of girders were placed six pairs of steel wedges, three over each girder, which were gently driven into place.

These wedges were each 33 in. long, 6½ in. wide, 1½ in. thick at the butt, tapering down to about ⅛ in. at the other end, which gave a slope of about ½ in. per ft. They bore on a ¾-in. plate 21 in. square which rested on the girders. When necessary, when the wedges had been driven in as far as they could without obtaining the full deflection of the girders, two pairs of wedges were driven a little more, allowing the third pair to be withdrawn and a shim plate to be inserted. Then the other two pairs were also taken out, one pair at a time and shim or filler plates inserted as before. Had only one pair of wedges been used over each girder, it would have been a very serious matter to remove them if the slope or length of the wedges had not been sufficient to secure the deflection of the girders which the weight of the superimposed building would cause. With three pairs side by side the change became easy.

When all of the brackets were bolted to the columns, the driving of the wedges commenced as follows: Two long steel rails, for use as rams to drive the wedges home, were slung from a movable frame on two sides of the columns so that the wedges could be driven

simultaneously over each girder and from each side. The men thus swung the four rails or rams simultaneously. When slack had been entirely taken out of the wedges over the first pair of girders, a similar operation took place on the next column, and when all of the columns had been so wedged, work was resumed on the first set again. Thus the operation was repeated in a number of stages, to avoid any danger of one column being lifted more than another.

The object of the wedging was to transfer the entire weight of the eleven stories above to the new girders, and to assure that the ultimate deflection of the girders had taken place before removing the columns below. As the following table shows in detail, the girders deflected from ¼ in. to 33/32 in., and the columns were raised from 7/16 to 11/32 in.:

FIG. 7. SCAFFOLDING FOR REPLACEMENT OF STONE FACING

EFFECT OF WEDGING

Column Number	Column Raised, In.	Girder Deflected, In.	Combined Effect, In.
22	1/4	15/32	23/32
32	5/16	13/16	36/32
33	5/16	13/16	36/32
34	3/8	1/4	20/32
35	7/16	3/8	26/32
36	7/16	1/2	30/32
37	11/16	5/16	32/32
38	1/2	15/32	31/32
39	5/16	25/32	35/32
29	3/16	19/32	25/32

No effort was made to hurry the wedging, which was spread over two weeks.

It is probable that this wedging was carried slightly farther than necessary, as daylight was seen at the joint of the columns to be removed and the columns which were left in place, which was hardly necessary evidence, as tapping with a hammer clearly indicated that the lower columns had been relieved of their load. As the upper columns were raised, the section of the column below seemed to follow up, due to expansion of the cast iron and to the release of pressure on the foundations. Theoretically the columns should not have been raised at all, and the wedging performed only for the purpose of getting the ultimate deflection out of the girders and just releasing the strain on the columns. Practically, however, the results are as shown on the preceding table. After it was evident that the new girders were carrying the entire load, the new concrete floor was put in place, without, however, causing any further deflection of the girders.

The next operation was to burn off the heavy cast-iron columns. One complete cut from the acetylene gas torch at an angle of 45 deg. permitted an easy removal of the old columns. When they had been removed, each pair of girders was connected by a pair of plate-girder diaphragms directly under the superimposed columns and on top of these diaphragms and under the columns were placed two broad wedges, 21 x 1¾ x 24 in. These wedges were driven snug, simply to take up the slack without releasing the pressure from the wedges on top of the plate girders. The diaphragms would carry half the load above if called upon to do so, and were simply inserted as an additional factor of safety. The space between diaphragms and girders will be filled with concrete, and the cast-iron columns above will be filled with grout or concrete up to the top of the 1¼-in. bolts, to avoid any danger of the latter rusting out. The brackets themselves, which are in the partition walls, will also be encased in concrete.

The contractors were: The Whitney Co., general contractors; A. E. Norton, Inc., steelwork; Miller-Daybill & Co., shoring.

O. F. Semsch, N. Lorentz Malmros, and A. I. McGloughlin, architectural engineers for Walter B. Chambers, deserve great credit for the unique design and capable supervision. F. Rabbe, Jr. was the superintendent on the site for the architect, who retained the writer as consulting engineer.

Number of Persons in Family and Dwelling 4.3 and 5.1, Respectively

The average number of persons to a family in the United States, according to the 1920 census, is 4.3 and the average per dwelling is 5.1. A family is any number of persons living together as a single household, whether it be one person or all the occupants of a hotel. A dwelling is any structure whatsoever in which one or more persons regularly sleep, be it a tent or an apartment house sheltering many families. Both the size of families and persons per dwelling have declined in each decade since 1880, as follows: Families, 5; 4.9; 4.7; 4.5; 4.3. Persons to each dwelling, 5.6; 5.5; 5.3; 5.2; 5.1. In general, the average size of families (1920) is greatest in the Southern and least in the Western states, but for individual states the range is from 3.5 in Nevada to 5 in North Carolina. Population per dwelling (1920) is greatest in New England and the Middle Atlantic States and smallest in the West, while by separate states the minimum is 3.7 in Nevada and the maximum 7.8 in New York. For the entire United States, the 1920 population is 105,710,620, in 24,351,476 families, living in 20,697,004 dwellings, the corresponding figures for 1880 are: Population, 50,155,783; dwellings, 8,955,812; families, 9,945,916. The number of families per dwelling was 1.18 in 1920 and 1.1 in 1880

A Few of the Engineering Problems of Municipalities

Abstracts of Papers and Reports Presented at the Annual Convention of the American Society for Municipal Improvements Held at Baltimore, Md., Oct. 24-28, 1921

Report on Traffic and Transportation

By Arthur H. Blanchard

Professor of Highway Engineering, University of Michigan, Ann Arbor, Mich.

The Committee on Traffic & Transportation (consisting of Prof. Blanchard, chairman, Robert Hoffman and Charles O. Boyd) submitted the following report:

Investigations conducted during 1921 influence the committee strongly to urge the general adoption, by municipal governments, of the recommendations embodied in its 1920 report relative to the following subjects:

(1) Use of "dummy cops" at street intersections.

(2) Installation of rotary traffic at street intersections, wherever practicable.

(3) Design and construction of long-radius curb corners.

(4) Economic design of street widths on through thoroughfares in small towns and cities.

(5) Utilization of by-pass highways for towns and cities located on important national, state, and county trunk highways.

(6) Consideration of the installation of motor bus routes in municipalities when an extension of the public passenger transportation system is required, in view of the resulting advantages of such installations from the standpoints of maintaining the maximum practicable traffic capacity of streets and of avoiding the use of car tracks in roadways.

Based on a careful analysis of public passenger transportation, the committee considers that it is highly desirable, from the standpoints of economic public service transportation and the efficient use of municipal streets by traffic, that the society should strongly condemn the development of "wild-cat" jitney service. Not only is the installation of such service undesirable from the standpoint of overcrowding of streets with five-passenger public transportation vehicles but it is obviously unfair to public service corporations, operating under franchises, to be forced to compete with a jitney service which almost universally is operating on an uneconomic basis.

Highway Transportation Division Recommended

The committee recommends that a highway transport division should be installed in engineering or highway departments of municipalities having a population of over 100,000. The duties of this division would be to deal with all matters pertaining to traffic and transportation which affect the economic design and maintenance of streets and their efficient use by pedestrians and all classes of vehicles.

One of the important functions of such a division would be to make highway transport surveys as preliminary to the design and redesign of streets, the determination of efficient methods of maintenance and the formulation of recommendations pertaining to efficient traffic regulations.

A highway transport survey embodies all investigations in the field and office which are necessary to determine the probable amount, character and effects of the future traffic which will use a given highway during the lives of its several component parts. Such a survey for a given street may cover a consideration of all of the following factors: (1) All highway elements which affect economic highway transport; (2) legislation relative to franchises and rates, weights, dimensions, and speeds of passenger cars, trucks, tractors and trailers; (3) state and urban traffic regulations; (4) vehicular and population statistics; (5) traffic censuses of motor and horse-drawn vehicles and cars operating on tracks; (6) vehicular operation as affecting roadways and other parts of highways; (7) present and future traffic and commercial transport developments in such fields as agricultural and dairy farming, mines, quarries, gravel and sand pits, oil fields, lumber tracts, fisheries, plants, factories, wholesale and retail stores, parks and parkways, summer and amusement resorts, and real estate improvements, which affect or will affect the traffic on the street under consideration; (8) common carriers such as steam and electric railroads and waterway transportation companies and their relationship to street traffic; and (9) the characteristics of the methods of highway transport such as street car, rural, interurban and urban motor-bus operation, municipal haulage, long and short general rural haulage, rural motor express, intercity haulage, intercity express, and horse transport.

Men assigned to a highway transport division should be experienced highway engineers who have or are rapidly acquiring a knowledge of the following subjects: City planning; highway transport economics, legislation, surveys and methods; highway transport management, including delivery systems, scheduling and routing; traffic regulations; interrelationship of highway, railway and waterway transport; port, terminal and warehouse facilities; and the fundamentals of the mechanism and operation of automobiles, motor trucks, tractors and trailers.

* * *

Subways for City Transportation

By Robert Ridgway

Chief Engineer, Transit Commission, New York

Prior to the War, New York's subways cost to construct, including track, stations and other appurtenant work, maintenance and underpinning of abutting buildings and maintenance and restoration or reconstruction of surface and subsurface utilities, but excluding the furnishing and installation of third rail, signals, lights and other equipment, from $700,000 per track-mile in an outlying portion of Brooklyn to $2,500,000 per track-mile in a very congested section of lower Manhattan. Similar costs at pre-war prices for a steel elevated railroad were about $275,000 per track-mile for a three-track line and about $235,000 per track-mile for a two-track line. These costs would be much greater at the present time. To put it in another way: a given amount of money for rapid transit construction would build from four to five times as much elevated line as subway.

With these facts in mind it would seem that subways, notwithstanding their many advantages, must be confined to the congested portions of a city, using elevated structures or open cuts for the extensions into the less congested and outlying parts. It is a fact that other considerations than financial ones sometimes govern. For instance, an elevated railroad could be constructed in the narrow street of the most intensely used business section of a city for a fraction of the cost of a subway, but public opinion might not permit it to be built there and might insist upon having the subway, notwithstanding the much higher cost.

First Subway Work in 1900

In 1900, the City of New York, by the Rapid Transit Railroad Commissioners, began the construction of the first subway to be municipally owned and to be privately operated under a lease running 50 years, with a provision for a 25-year renewal. Operation was begun in October, 1904, in the first portion to be completed and was extended from time to time until, in 1908, the first two contracts were in full operation.

The number of passengers carried by the Dual System, that is, the rapid transit lines, for the year ended June 30, 1921, amounted to over 1,418,000,000. The average on business days is about 4,172,500 and the maximum for one day was about 4,929,000. This occurred in February, 1920, on the occasion of a snow storm, partially tying up surface

car traffic which increased subway traffic. These figures are exclusive of the passengers carried by the surface lines, the bus lines and the suburban services of the trunk line railroads.

The intensively developed portion of New York is beyond question a subway district but the roads are taken out of the ground as the outlying or less congested portions of the city are reached and the extensions are carried on elevated structures. Compared with subways, elevated railroads are simple to construct and can be built in far less time. In normal times, an elevated structure can be finished ready for track in from 18 to 24 months of the date when work in the field is begun and the discomfort to the public and interference with traffic on account of the construction, is confined to a small part of this period. The disturbance of the street surface and of the utilities underlying it is relatively slight. With a section of a subway, on the other hand, from 3 to 4 years' time is usually required for construction and, except where it is at such depth that the work is done by tunneling methods, it requires generally the entire reconstruction of the street and of the sewers, water and gas mains and other structures beneath it.

An analysis of 57 subway contracts showed the total expenditures on account of them to have been distributed as shown in the accompanying table.

PERCENTAGE DISTRIBUTION OF SUBWAY CONSTRUCTION COSTS

Item of Work	Percentage of Cost
Earth excavation	25.6%
Rock excavation	15.9%
Concrete	14.0%
Riveted steel, furnished and erected	7.4%
Rolled steel, furnished and erected	7.2%
Steel rods, furnished and erected	1.0%
Underpinning buildings	6.5%
Supporting existing railroads	2.7%
Construction of new sewers	3.8%
Relocating pipes and ducts in street	2.8%
Waterproofing, railroad ducts and miscellaneous work	13.1%
Total	100.0%

The design of a subway must take into account, among other things, the geological conditions, the location of the rock, if any, the character of the soft ground, the presence or absence of ground water, the widths of the street and the character of the buildings abutting on them, the character, size and number of the subsurface utilities, the surface tracks and the elevated railroads, if any, the depth to which the subway must be placed to cross over or under or to join other subways already constructed or to be constructed. Careful surveys must be made showing all of the conditions, reference points and bench marks established, borings made, the surface, subsurface and overhead structures located and plotted, notes made of the condition of pavements, buildings, etc.

New York's subways differ from those of other cities in that their trunk lines provide for express as well as local service in both directions. This means that four or more tracks are required.

The stations are of the local and express type. The local stations are located from ½ to ¾ mile apart and the express stations usually at longer intervals, generally from 1½ to 2 miles apart. The typical local station has side platforms and those of the express stations are usually between the local and express tracks. In the Interborough subway, the platforms of the express stations are about 480 ft. long to accommodate their 10-car trains, the cars of which are 51 ft., 2 in. long. The platforms of the original local stations now accommodate 6-car trains while those constructed within the past ten years are designed for the full 10-car trains. The cars of the Municipal Railway Corp. are 66 ft. long and the platforms of their local and express stations are now made 530 ft. long to accommodate 8-car trains.

The city-owned subways were built under construction contracts prepared by the commission's engineering force and the construction was supervised by it. The work, exclusive of Contracts 1 and 2, was divided into 87 construction contracts, in addition to which there were many other construction contracts for track work, station finish, yards, shops and miscellaneous work. The construction contracts varied from about $500,000 to $6,000,000 in value. Prior to 1912, the lump sum form of contract was used, but, since then, the unit price form has been employed except in a few special cases.

The cost of constructing the Dual System will be, when completed, over $400,000,000 and of equipping the lines and improving and extending the companies' own lines over $186,000,000. These costs include the city-owned lines built between 1900 and 1913, but do not include the extensive company-owned lines constructed prior to 1913. About one-quarter of the construction cost and all of the equipment cost are borne by the two operating companies and the two systems will include, when completed, approximately 70 miles of subway, 17 miles of railroad in open cut below street grades and on embankment, 126 miles of steel and concrete viaducts and bridges, a total of 213 miles of railroad and 619 miles of single running track. All but 10 miles of this total mileage of railroad is in operation.

* * *

Engineer Student and Public Service

By A. N. Johnson
Dean, Engineering College, University of Maryland

An Important Field which the engineer has scarcely entered, and in which he now plays but a small part, is the direction of public affairs. The role that is to belong to the engineer is hardly realized, even by the profession itself, much less by the general public. But there is arising in the minds of engineers of vision a realization of the larger field of usefulness that awaits the technically trained man.

All the many arguments that are to be found in the proceedings of engineering societies show conclusively, at least to the satisfaction of the engineers, that their training and attainments would secure for the public a more efficient management of many of its more important undertakings; and the engineers are probably right. But the fact remains that the public does not intrust its affairs to engineers, even in those instances where all agree that the technical skill of the engineer must be employed. And so the engineer reports, while someone else directs.

If members of the engineering profession should be intrusted with greater responsibility in the management of public affairs, and such has not happened, it seems obvious that the engineers themselves have not, as yet, made the right move for the desired end. That tradition is against such recognition, and that the engineer is usually handicapped by lack of intimate knowledge of the relation between political organization and management of public affairs, is to suggest that engineering schools have an obligation to assist their students to gain a different viewpoint as to what their careers may be. When the only outlook presented the student is to become a good technician, there need be little surprise felt if these men individually, or as a group, develop a field of activity that occupies in the public mind a position secondary to that of men who look forward to careers in public life and take, and are conceded, leadership in public activities.

It was with these considerations in mind that the following statement was written as it appears in the 1921-22 catalogue of the University of Maryland. Under the heading, Engineering College, it states that the courses are undergoing reorganization and that "the general purpose is to broaden the courses of instruction the better to prepare young men to enter the public service. The large public works program contemplated in practically every state in the union makes urgent the demand for engineers trained for such work. The public service demands the electrical and mechanical, as well as the civil engineer. Maryland needs such men to carry on her great highway and large public undertakings contemplated in various cities and counties. Such training seems pre-eminently a function of the State's university. It is not the intention that the subject matter of the courses shall be essentially different from that usually given, but that the viewpoint of the student and the application of the principles will be that of public service. In order to give the time necessary both to the technical subjects and to those of a more general character, a careful

revision of all courses of study is being made so that the utmost time available in each term may be used to the best advantage."

* * *

Sewage Disposal for Small Municipalities

By John F. Skinner
Principal Assistant City Engineer, Rochester, N. Y.

The Sub-Committee on sanitation, including sewage disposal (John F. Skinner, chairman) submitted the following report:

The present study is intended to cover villages and small cities. One principle only may be postulated which will apply to all cases, viz: Each situation is a distinct problem to be studied and solved truthfully, always remembering that the truth upon any subject is obtained by marshalling all the facts in their proper relations. In view of the above it may be helpful to outline the data to be considered, the conclusions therefrom, the resulting type of plant applicable, the elements of disposal plants and certain observations.

I.—Data to Be Considered

1. Physical Conditions.
   - A. *Area of Territory*
     - (a) Present
     - (b) Future
   - B. *Character of Territory*
     - (a) Compact or scattered
     - (b) Residential, commercial or industrial
     - (c) Flat or hilly, gentle or steep slopes
     - (d) Low, requiring pumping, or high, allowing gravity outfall
     - (e) Geology: sand, gravel, clay, quicksand, rock
   - C. *Population, Density and Total Numbers*
     - (a) Present
     - (b) Future
     - (c) Resident
       - a. Home and business
       - b. Home only (commuters)
     - (d) Nonresident (industrial)
     - (e) Seasonal (summer colony)
     - (f) Transient (summer resort)
2. Sewerage System.
   - A. *Character of Sewer System*
     - (a) Separate
     - (b) Combined
   - B. *Amount of Sewage*
     - (a) Dry weather flow } obtained by:
     - (b) Maximum flow }
       - a. Amount of water supply and population
       - b. Sewer gagings
       - c. Proportion of storm water admitted in case of a combined system
       - d. Precipitation, run-off data, percent impervious, etc.
   - C. *Character of Sewage*
     - (a) Domestic waste
     - (b) Industrial waste
       - a. Solids
       - b. Color
       - c. Odor
       - d. Source
       - e. Chemical constituents
       - f. Temperature
     - (c) Ground water
     - (d) Street wash (in case of combined system), quantity of manure, leaves, grit, etc., received through surface sewers
     - (e) Settleable and suspended solids with their settling rates
     - (f) Effect of various precipitants, especially in the case of preponderating trade wastes
     - (g) Oxygen demand — putrescibility
3. Body of Water Receiving Effluent
   - A. *Non-Potable, no Bathing*
   - B. *Salt Water with Beaches to Protect*
   - C. *Tidal Stream—Bathing*
   - D. *Fresh Water Lake*
     - (a) Bathing
     - (b) Water supply
   - E. *Fresh Water Stream*
     - (a) Large or small
     - (b) Riparian uses
     - (c) Industrial uses
     - (d) Bathing
     - (e) Water supply
   - F. *State Regulations Regarding Discharge of Sewage*
   - G. *Currents*—Dilution and dispersion
   - H. *Deep or Shallow*
   - I. *Constant or Variable Level*
     - (a) Fluctuation due to tides
     - (b) Fluctuation due to precipitation
     - (c) Fluctuation due to storage
   - J. *Temperatures*—Water and sewage
   - K. *Wind*—Prevailing direction and intensity
   - L. *Vegetation*
   - M. *Pollution Other Than By This Effluent*
   - N. *Protection of Fish, Oysters, etc.*
   - O. *Visual and Aërial Nuisance*
4. Funds Available for Sewage Treatment

II.—Conclusions From the Data

1. Volume of Sewage to be Treated
   - A. *Dry Weather Flow*—Present and future
   - B. *Maximum Flow* — Present and future
   - C. *Distribution* — Through day and week
2. Character of Sewage
   - A. *Variation in Density*
   - B. *Solids*—Settleable and suspended
   - C. *Oxygen Demand* — Putrescibility
   - D. *Color, Odor,* etc.
3. Character of Treatment Indicated
   - A. *Discharge into Non-Potable Water*
     - (a) Remove floating and coarse suspended objects
     - (b) Remove grit where necessary to prevent deposits in stream, lake or long outlet pipe
   - B. *Discharge into Small Non-Potable Stream*
     In addition to "(a) and (b)" above treat further sufficiently to prevent nuisance
     - (c) Remove settleable solids and 40 to 90 per cent of suspended solids by tank-treatment
     - (d) Oxidize effluent
   - C. *Discharge into Large Potable Stream or Lake where there is Ample Dilution and Oxidation.*
     Treat as in (a), (b) and (c). "(c)" may be omitted if the effluent does not appreciably effect the receiving body of water
     - (e) Disinfect the effluent when sewage pollution, possible from the effluent, can be detected near bathing beaches or water works intakes
   - D. *Discharge Into Small Potable Stream or Lake*
     Treat as indicated in "(a), (b), (c), (d) and (e)" above

III.—Type of Plant Applicable

Without entering into controversy as to the amount removable by screens, in this paper, *coarse* solids are distinguished from *fine*, in that the latter are best removed by sedimentation or precipitation.

The above operations may be accomplished respectively by means of the following devices:

- (a) Remove floating and coarse suspended objects — by coarse racks, fine racks or mechanical screens
- (b) Remove grit—By detritus chambers
- (c) Remove settleable solids and 40 to 90 per cent of suspended solids—By tank treatment with or without precipitants
- (d) Oxidize Effluent—By irrigation, sand filtration, contact beds, trickling filters, or aëration or activation
- (e) Disinfect the Effluent—By liquid chlorine or bleach

IV.—Elements of Disposal Plants

1. Removal of Solids
   - A. *Screening Devices*
     - (a) *Coarse Racks:* Bars 2 to 4 in. apart for large objects in Combined Sewage
     - (b) *Fine Racks:* Bars ¾ in. apart for coarse floating and suspended matter in fresh sewage, when followed by tank treatment
     - (c) *Fine Mechanical Screens:* For coarse floating and suspended matter, particularly in the case of stale or septic sewage when followed by further treatment. The removal is mainly garbage. Also where no further treatment is required, as above in II - 3 - A and C.
   - B. *Detritus Chambers:* For the removal of grit and heavy (mainly inorganic) solids which will settle from a stream flowing at a mean velocity of one foot per second. This should precede fine racks or screens; more important for combined sewage
   - C. *Tanks:* For the removal of settleable solids and 40 per cent to 90 per cent of suspended solids
     - (a) Septic tanks, 8 to 12 hours detention
     - (b) Biolitic tanks
       - a. Agitation chamber 6 to 8 hours detention
       - b. Settling chamber 2 to 3 hours detention
     - (c) Imhoff Tank
       - a. Flow chamber—3 hours mean detention for best removal
       - b. Digestion chamber—4 to 6 months sludge
     - (d) Settling Tank—3 hours mean detention with continuous removal of sludge for separate digestion, with or without a precipitant
2. Oxidation of Effluent
   - A. *Dilution* in lakes or streams

B. *Broad Irrigation:* Only applicable under unusual conditions of isolation and cheap land
C. *Sand Filters:* Only applicable where large areas of natural sand and gravel are available in suitable location
D. *Contact Beds:* For locations so close to habitations that the spray from sprinklers would cause nuisance
E. *Trickling Filter*: of broken stone or brush. This is probably the best known method of artificial oxidation of tank effluent. When carefully designed and constructed they have been uniformly successful on well settled sewage which does not contain unusual elements, trade wastes, etc. They are expensive to construct but cheap to operate. They should be followed by settling basins for secondary sludge.
F *Aëration or Activation:* The process known as "Activated Sludge" produces a well oxidized effluent by means of agitation and thorough mixing of sewage, air and previously aërated sludge. It is a plant relatively cheap to install but most expensive to operate. It requires less area than any other artificial method of oxidation but it is limited to situations where cheap power is available where fertilizer can be produced as an offset to the expense of operation and upon a large scale. Certain adaptations still in the experimental stages offer promise of success.

3. DISPOSITION OF SOLIDS
A. *Screenings*
(a) Incineration
(b) Composting for fertilizer
(c) Treated as garbage
a. Buried
b. Burned
c. Reduced
B. *Grit:* Dumped for filling
C. *Sludge*
(a) With or without digestion
a. Dumped in deep water or discharged during flood conditions
b. Lagooned or dried in furrows and covered
(b) With digestion — Drained on drying beds and used
a. For fertilizer
b. For fertilizer base
c. For filling

4. DISPOSITION OF EFFLUENT
A. *Direct* into receiving body of water
B. *Through Long Conduit* to avoid local pollution
C. *Chlorination* where necessary with
a. Liquid chlorine or
b. Bleach
To Protect
(a) Water Supply
(b) Shell Fish
(c) Bathing Beaches

V.—Observations

There are certain details in the construction and operation of disposal plants which are too often overlooked, as they are generally omitted in the literature of the subject. Provide the plant, where necessary, with: (1) Water under pressure; (2) industrial railway; (3) light; (4) heat in buildings where men work in cold weather; other buildings will be kept from freezing by the sewage; (5) repair shop with forge, pipe cutter, stock and dies and bench tools; (6) laboratory and apparatus; (7) power for the above and other uses; (8) labor under competent supervision.

The moving of sludge, grit and screenings is often most conveniently accomplished by an industrial railroad preferably operated by storage battery locomotives, as this method obviates the danger of exposed trolley wires. In fortuitous situations like two of the present and two of the future plants of Rochester, N. Y., power is obtained from the fall of the sewage and fuel is only used for heating, otherwise it must be provided and becomes an important element in the expense of the plant.

A certain amount of labor may be effectively employed in hosing and washing down decks and walls, skimming tanks, agitating scum in gas slots by streams or by the use of tampers to prevent the formation of a continuous crust and afford free vent for the gas. Labor is also required in operating gates, removing sludge, grit and screenings; raking over the surface of trickling filters when the first "ponding" appears, inspecting and cleaning spray nozzles daily as well as the distributing and collecting pipes. Such operations are most certainly performed when a methodical schedule is maintained and directed by a responsible man on the job.

Flies—Flies in large numbers are disgusting around a disposal plant and can be largely avoided by reasonable precautions. As they come to obtain food, they can be discouraged by keeping all surfaces washed clean and by barring floating solids from quiescent water in tanks. In the relatively rapid current of a detritus chamber in advance of screens, it is only necessary to keep the walls washed clean. Grit from a properly operated detritus chamber will not attract flies, neither will well-digested Imhoff sludge whether wet, spadable or dry. Fine screens and efficient scum boards, hosing and occasional skimming will minimize the floating solids in a settling tank, or reduce them to such size that they will not support a fly. Screenings attract flies as they are largely composed of garbage. They should be covered with grit, earth or ashes or compacted and sprinkled with borax solution. Small moth flies which are found in warm weather on and above a Trickling Filter come from the larvae resident on the stones just below the surfaces. They do not travel far from the filter and are not objectionable. They may be kept out of other portions of the plant by screening doors, windows and other openings, and by providing curtain walls dipping below the surface of the sewage.

Odors—The best plan for dealing with odors is to surround the plant by a large tract of land municipally owned and controlled, but even then certain odors which reach to considerable distances may produce nuisance unless controlled.

Well digested Imhoff sludge is not objectionable and can be noticed only in the immediate neighborhood. Odor from screenings can be controlled by covering as suggested above. Liquid sewage when undisturbed does not give much offense, but when it is broken up in rapid currents by means of baffles, or tumbled over weirs, it becomes more noticeable.

Odors have been found objectionable at distances of half a mile when sewage is blown into the atmosphere as spray, by air under pressure. This nuisance does not occur when the wind direction is unfavorable, nor yet when there is perfect quiet. A strong wind or good breeze does not seem to cause trouble to leeward for the vapor is too attenuated when mingled with a considerable volume of air. Smells seem to be carried furthest with a scarcely perceptible drift of the air. The remedy for this condition consists in covering so that rising spray or vapor will impinge upon the under surface of the cover and be condensed.

At the main (Irondequoit) sewage disposal plant of Rochester, N. Y., where the total cost, including the site of 315 acres on the shore of Lake Ontario, was $975,500, and where 45 ft. head is available most of the time, the cost of accessories such as water works, railroad, grading, light and power was $108,000. In general such accessories, including equipment of shop and laboratory, may amout to 10 or 15 per cent of the cost of the plant.

* * *

Sludge Disposal at the Rochester Sewage Disposal Plant

BY N. ADELBERT BROWN,
Engineer in Charge of Sewage Disposal, Rochester, N. Y.

THE SLUDGE BEDS at the Rochester sewage-works were designed on the generally accepted rule of 1 sq.ft. to three persons, and under the local climatic conditions this area has proven satisfactory. The Irondequoit plant handles combined sewage. The ten Imhoff tanks are preceded by grit chambers and Riensch-Wurl screens and are designed to serve 200,000 people. There are forty individual beds, each approximately 44 ft. square. The tanks are built in double units with a common sludge trough. This trough is on the wall between two rows of four beds, allowing the sludge from any tank to be diverted to one of eight beds. The troughs have a slope of 1 in 50, which gives a high velocity, and are nearly self cleaning. The sludge is discharged onto the center of the bed through an 18-in. opening controlled by stop boards in the side of the trough. The sludge falls onto a concrete splash plate. A depressed channel extends transversely to the sludge troughs between

the first and second and the third and fourth beds of each tier. This channel is 4 ft. below the top of the bed and 9 ft. deep and 9 ft. wide. In this channel is laid a narrow gage track for the sludge cars and on the walls are tracks for a gantry crane.

The beds are level and consist of 2 in. of fine sand, 3 in. of coarse sand, 8 in. of gravel and 6 in. of broken stone. They are underdrained by 3-in. farm tile laid with open joints, 8 ft. c. to c. These tile discharge into an open drain under the track channels.

The Imhoff tanks have two rings of perforated pipe in each hopper and the sludge is agitated each week. The sludge pipes are also blown out and left filled with clear water after each drawing. No cones are found in the sludge surface and no plugging of the pipes has been experienced.

Drawings are made during the season as often as the removal of the dried sludge permits. Nine inches of wet sludge are drawn on a bed. The drawing season is reasonably constant, as shown by the following table:

Year	First Drawing	Last Drawing	Period in Days
1918	April 15	November 15	214
1919	April 29	December 10	225
1920	May 7	December 21	228
1921	March 24		

While the season is nearly the same each year the number of drawings varies according to the weather. In 1920 each bed received nine fillings, an average of one every 25 days. In 1921, an extreme drought permitted seven drawings between March 24 and June 23, an average of one every 13 days, with the longest drying period 22 days and the shortest 10 days. Up to Aug. 10 four additional drawings have been made which gives a season's average to date of 12.6 days per bed.

To remove the dried sludge, two trains of 6½-cu.yd. industrial cars are used. The trains are run in the depressed channel under the gantry crane which lifts the car bodies from the trucks and sets them on the bed and replaces filled bodies on the trucks. In loading cars, stone forks are used and the sludge lifted in cakes approximately 12 in. square. A few extra car bodies set on the beds permits the moving of trains without delaying the labor force. The trains are hauled by storage battery locomotives and the crane is electrically operated, as power is developed at this plant from the effluent.

The usual force consists of one foreman, one hoist man, two locomotive runners and eleven laborers. Eight men do the loading, one is on each train to dump the cars and one is at the dump to keep the track clear. This crew will remove on an average 200 cu.yd. of loose dry sludge in 8 hr. With labor at 50c. and 55c., and neglecting power costs, this sludge is delivered to the spoil bank at 33c. per cubic yard.

During much of the season, the sludge is sold to farmers as removed from the beds. The cars are run to the tipple and dumped directly into the wagons or trucks. As the tipple is located further from the beds the additional haul and delays in dumping increase the cost of removal 10 per cent.

The sludge when drawn contains from 79 to 86 per cent of moisture. It is more dense in the first drawings each season and is thinner as the season progresses. At the time of removal the moisture is reduced to from 50 to 60 per cent. A rain on the beds after the cracking has occurred packs the sludge so that it is difficult to reduce the moisture below 60 per cent in any reasonable time. The shrinkage in drying is normally a little more than half of the wet volume. Analysis of a dry sample yields 2.2 per cent nitrogen and 56.3 per cent mineral matter.

Due to the depth of the tanks, the entrained air bubbles expand greatly when drawn onto the bed and make the dried sludge a light, porous cake.

Quantity of Sludge

The quantity of sludge varies, but the average for three years has been 1.51 cu.yd. of wet sludge per million gallons. In a large plant the disposition of the dry sludge becomes a problem. Realizing this, the plant at Rochester started in 1918 to develop a demand for it as a fertilizer. During that time it was given to any farmer who would load and draw it away. The plant is located in a fruit and truck garden section having a sandy loam soil. Reports of the use of this fertilizer were not enthusiastic. This was in part due to a belief that enthusiastic reports would increase the price. In 1919 a charge of 50c. a load was made, the buyer loading from the dump, and more was drawn away than in the previous year with no charge. A proposal came from the farmers that with a more convenient method of loading they would pay a higher price. The tipple was erected and the price put at 75c. per car, the car holding nearly 2 cu.yd. When sludge is not being removed, the dump is still open at 50c. per yard. During 1920 the income from this source was $1,015. To July 1, 1921, it has been $650. The income is small but the disposal of continually increasing quantities is preventing an accumulation on the grounds of the plant.

It is being hauled for distances up to five miles. In peach, cherry and pear orchards it is used as a top dressing spread around the trees. On the truck farms it is spread at the rate of 50 cu.yd. per acre and ploughed under. The truck men use it under corn, tomatoes, celery, cabbages and melons. It is still impossible to obtain reports favorable to sludge, but the same farmers are drawing it after four years of trial and using more than ever before.

St. Paul to Vote on Abandoning Commission Government Plan

The Charter Commission of St. Paul, Minn., has submitted a draft of a proposed new charter to the City Council and the latter has set Dec. 29 as the date of a special election to vote on the scheme.

The charter provides for changing from the present commission plan to the so-called federal plan, with complete separation of the legislative, executive, and judicial departments of the city. If the new charter is adopted there will be a mayor vested with broad executive power, elected at large; a council of 15 members, of which 12 will be elected one from each of as many wards, and three elected one each from three districts composed of four wards each. The departments of Public Works, Public Utilities, and Safety will be vested in single commissioners, but there will be boards in charge of Park, Educational, Library, and Efficiency departments, the latter including civil service. There will be a City Planning Commission consisting of the mayor, the chairman of the Park Board, a civil engineer, an architect, a landscape architect, and three citizens of undesignated class.

The Commissioner of Public Works is to be a registered professional engineer of ten years' experience as a designing and constructing engineer. He is to be the chief engineer of the city and no limit is placed on his salary. The mayor will be paid $7,500 a year and the councilmen will receive $25 per month.

As the charter was originally drawn $6,000 was the limit for the Commissioner of the Department of Public Works, but this limitation was removed at the request of the Engineers' Society of St. Paul. They also requested that he be a registered professional engineer, which was inserted in the final draft of the charter, thus supporting the new registration law of the state.

The mayor will appoint all executive officers excepting the comptroller and he will appoint the members of all boards, with the exception of the Board of Efficiency which will be appointed by the comptroller. The latter is an elective official.

Superpower Report Recites Gains from Power Consolidation

Economic Advantages in Joining New Steam and Hydro-Electric Plant With Present Utilities on Eastern Coast

THE so-called superpower report made to the United States Geological Survey by a group of engineers headed by W. S. Murray, of New York City, has just been made public. This is a short-period study into the "possible economy of fuel, labor, and material resulting from the use in the Boston-Washington region of a comprehensive system for generating and distributing electricity to transportation lines and industries." The investigation was made under an appropriation of $125,000 plus $26,000 contributed by utilities, and was completed within the year ended the first of last July.

The so-called superpower zone lies between the thirty-ninth and fourty-fourth parallels of latitude, and extends from the coast approximately 150 miles inland, that is roughly the Atlantic coast from Boston to Washington and as far west as Harrisburg and Utica. Within it is concentrated one-quarter of the population of the United States and are operated, most of them independently, 315 electric public utilities, 18 steam railroads, and 96,000 industrial plants. The idea of the superpower system was to co-ordinate and supplement the existing utilities so as to carry to a higher degree the economies incident to their present operation. The engineering staff set out to determine the total amount and location of the power load that would be required for private, municipal, industrial, and railroad purposes at a date sufficiently in advance to permit the construction of a system of the highest economy to supply it. The date chosen was 1930. In the study special reports were made on electric utilities, proposed electrification of heavy traction railroads, performance and cost of the superpower system, steam-electric plants, hydro-electric plants, transmission systems, reliability of service, relation of coal and coal deliveries to the system, use of process fuels, basic costs, and existing stations.

The report states that the market for superpower energy will be furnished by the electric utilities, the industries, and the railroads. The estimated requirement of energy supplied through the electric utilities for municipal, private, industrial, and railroad purposes in 1930 is 31,000,000,000 kw.-hr. This energy could be supplied by a co-ordinated power system at an annual cost of $239,000,000 less than by the unco-ordinated system now in use. The total investment in generating and transmission facilities for such a system would be in excess of $1,000,000,000, of which $400,000,000 will represent the value of existing facilities. Within the superpower zone there are 36,000 miles of railroad, measured as single track. Of this total about 19,000 miles can be profitably electrified, so as to yield by 1930 an annual saving of $81,000,000 compared with the cost of operation by steam. The capital expenditure necessary to electrify the 19,000 miles would be $570,000,000.

It is believed that the quickest return on the investment in a superpower system would be obtained by following in chronological sequence an order of procedure as follows:

1. The construction of a steam-electric plant near Pittston, Pa., to supply a part of its energy to the anthracite division of the superpower zone and the remainder to the metropolitan division, particularly New Jersey.

2. The construction of a steam-electric plant near Sunbury, Pa., to supply a part of its energy to the anthracite division, a part to the Reading load center, and the remainder to Philadelphia.

3. The construction of hydro-electric plants on the Delaware and Susquehanna Rivers to supplement the steam plants indicated above.

4. The progressive development of the Hudson River projects to meet the growth of energy requirements at the Schenectady, Utica, Poughkeepsie and Pittsfield load centers.

5. The construction of a steam-electric plant near Boston to supply the Boston, Lowell and Newburyport load centers.

6. The construction of a steam-electric plant near New Haven to supply the New Haven, Bridgeport, Waterbury and Norwich load centers.

7. The partial construction of the first hydro-electric plant in the development of the Potomac River as soon as the power demands of the Baltimore and Washington load centers require additional plant capacity.

It is stated that the hydro-electric resources of the district are comparatively small. When the increases during the last ten years are projected to 1930, about 21 per cent of the total energy requirement can be supplied from water power, that is about six billion kilowatt-hours. However, some of the best coal deposits in the world lie near this territory and the prime economic purpose should be so to join the hydro-electric supply power to the steam electric supply as to produce a maximum of energy for a minimum investment of capital and a minimum operating expense. This means locating the steam-electric plants so as to obtain the fullest advantage of low freight rates, easy coal-delivery routes and ample condensing water.

PROPOSED HYDRO-ELECTRIC DEVELOPMENT

	Capacity, Kw.	Output (Millions of Kw.-Hr.)	Investment	Production Cost (Mills per Kw.-Hr.)
Potomac	200,000	950	$22,000,000	3.36
Susquehanna	185,000	1,230	28,000,000	3.22
Delaware	350,000	1,250	51,500,000	5.95
Hudson	150,000	900	38,350,000	5.84
Connecticut	165,000	760	29,000,000	5.455

The average capacity of the 558 electric utility plants now in operation in the zone is 7,900 kw. and that of the steam-electric plants, 10,000 kw., while the hydro-electric plants average only 2,800 kw. The capacity of the base load steam plants projected would range from 60,000 to 300,000 kw., and in none of them would there be a turbo generator having a capacity of less than 30,000 kw.

The average unit production cost for electric utilities in 1919 was 1.98c. per kilowatt-hour, and the cost of the electric power produced by steam was 2.12c. and that of hydro-electric power, 0.94c. In the steam-electric base load plants for the superpower system the production cost based upon the same capacity factor that is applied to independent electric operation would be 0.99c. per kilowatt-hour, as compared with 2.12c. The unit investment cost in new power plants for the superpower system is $118.25 per kilowatt of effective capacity. That for all plants is $125 per kilowatt. The unit reproduction cost of the electric utilities in 1919 was $156 per kilowatt.

It is also stated that under present construction and operating costs power purchased at Niagara or on St. Lawrence River at $20 a horsepower ready for transmission at those points at potentials of not less than 220,000 volts, can be placed at Utica and Schenectady, N. Y., and at Northampton, Mass., for 4.6 mills per kw.-hr. and at Paterson, N. J., for 5.7 mills. These figures assume purchases of not less than 300,000 kw. delivered at a load factor of not less than 80 per cent.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

National Societies Should Act On Highway Bridge Safety

Sir—The deplorable failure of the Third St. bridge at Chester, Pa., described in your issue of Sept. 15, by which 24 persons lost their lives, calls for more extended comment than it has received in the daily and technical press. It is very clear that neither your editorial note of Sept. 22, which ascribed this "accident" to a "cracked plate which somebody's conscience had allowed him to slip back into place" nor the letter of Edward Piercy, in your issue of Oct. 13, according to whom "the blame rests solely on the man or men who inspected or passed such a piece of work" goes to the root of the matter. The really important question is: What safeguards are there against similar failures on the thousands of highway bridges all over this broad land?

Is there any systematic procedure by which the plans for new bridges are examined and approved and their construction supervised by competent state officials?

Is there any periodic inspection of existing spans, to ensure their strength under the constantly increasing loads?

An examination of the laws in the different states shows that the provisions for the protection of the public are very inadequate. In the state of New York, for instance, there seems to be at present absolutely no supervision under state authority, as the law which formerly empowered the state engineer to stop traffic over bridges found to be unsafe was repealed some years ago. This retrograde action is said to have been due to the country members in the legislature, whose constituents found the maintenance of safe bridges unduly burdensome. As a consequence neither the state engineer nor the state highway department has any jurisdiction in the matter of bridge construction or maintenance. Except in the larger cities, this important matter is entirely in the hands of town and county boards whose qualifications and interest in the subject are, as a rule, extremely meager.

In former years vehicles were much lighter and the highways were used almost wholly by nearby residents, so that local control was natural and was not likely to lead to serious accidents. At the present time, even in many quite remote districts, there is a heavy traffic of travelers from distant points riding in high-speed touring cars, while heavy motor trucks are numerous. The strength of bridge spans has therefore become a matter of general concern and should be ensured by state, if not federal regulation.

As a matter of fact, even a cursory examination of the bridges on an average country road shows a very unsatisfactory state of affairs. They are as a rule of all ages, types and conditions of repair, some new, others 30 or more years old, of very light construction and with poor details.

It is rather appalling to realize that in this state there is absolutely no power except public opinion compelling the local authorities to make repairs to a bridge, even when it is manifestly unsafe; while public opinon is very difficult to arouse in matters of this kind.

In proof of the last statement, the writer would refer to his personal experience in the case of a bridge in the Adirondacks which crosses the Ausable River above the village of Keene Valley.

This bridge is a light pin-connected pony truss 75 ft. in length and about thirty years old. It carries a very heavy traffic during the summer season. About five years ago one of the abutments was washed out, allowing the steelwork to drop into the rocky river bed, and bending it seriously. Since that time, the bridge, which was rebuilt, using the old material, has been in very poor shape. Many of the eyebars are badly bent and the end posts are out of plumb, the top overhanging the bottom as much as 12 in. in a height of 8 ft. The entire upper chord is very much out of line. A moment's inspection is sufficient to show the dangerous condition of this bridge, as there is no lateral system or bracing of any kind to keep the top chord from buckling.

In the face of these facts the writer found it impossible to arouse much interest in the condition of the bridge among either the local residents or the summer visitors. The structure has remained in its precarious condition for four or five years, except that one of the end posts has been pulled into line and secured to a tree by a piece of telegraph wire. As a result of renewed agitation it seems possible at the present writing that some repairs may be undertaken before long, although the town board is much averse to spending even the moderate sum required to make the bridge reasonably safe.

In view of the rigid regulations for building construction, steam boilers, etc., now so general, the absence of similar restrictions in the case of bridges, where proper supervision is at least equally necessary, is remarkable.

The need for reform seems sufficiently great to call for action on the part of the national engineering societies, who of late, through various agencies, have exerted so powerful and beneficent an influence in questions of this kind.

The purpose of this letter is to elicit expressions of opinions from your readers so that the matter may be fully discussed in all its phases.

New York, Oct. 22.

HENRY GOLDMARK,
Consulting Engineer.

Two Veterans on the Engineer Corps

Sir—Your issue of Oct. 6 contains references to the pamphlet prepared by a committee of the A. A. E. in the matter of the Department of Public Works which makes some statements that cannot be passed without challenge.

The writer is strongly in favor of the establishment of a Department of Public Works and is in sympathy with much of this pamphlet. Certain statements, however, are made in the pamphlet which, to the writer's personal knowledge, are not wholly correct.

Military engineering is as much of a specialty as any other branch of the profession and the training of the Corps of Engineers is and should be primarily along this line. It is only through this military training that a proper sense of relative military values becomes appreciated. These values are entirely different from those developed in civil engineering as time is the item of primary importance instead of the cost and economics as in the case of civil engineering.

Generally, in France, a large part of the friction between regular and volunteer officers was caused by the lack of understanding on the part of volunteer officers of proper relative military values and in these cases it is safe to say that generally the regular officer was more nearly right than the volunteer.

On page 7 of this pamphlet there occurs the following statement: "In the general case, those officers, regular and temporary, who were the most successful in engineering work in France were those who one way or another had succeeded in getting their work practically out from under the Chief Engineer and who were able to manage it under the Commanding General without interference on the part of the Chief Engineer or of the regular army engineering establishment in the United States." The next paragraph furnishes the numerous illustrations quoted in the article in *Engineering News-Record.*

As a matter of justice to the Corps of Engineers, the writer wishes to take exception to these statements. It is a very debatable question whether the railroad service, the chemical warfare service and the operation of ports was or is properly a function of the Engineering Department. Certainly the Corps of Engineers could not be expected to become expert in these lines and in the reorganization of the army the chemical warfare service is made a separate department as it should be. The Purchasing Department of the A. E. F. certainly was not properly a function of the engineers alone. The engineering section of the Gen-

eral Purchasing Board, however, was continuously under a regular officer and it operated efficiently. The construction of ports, cantonments, hospitals, etc., was also under a regular officer reporting to the Chief Engineer except for a few months late in 1917 and early in 1918 when a small portion of the port and railway construction reported to the Transportation Department. This work, however, was later returned to the Chief Engineer, and aside from this brief period all construction was under the direction of the Chief Engineer throughout the history of the A. E. F. It was the writer's experience with one of the Directors of Construction and Forestry, under whose immediate direction a large portion of this work was done and whose chief staff officer, as well as himself, was a regular, that almost the first question asked on the inspection trip was whether any delays were being experienced due to red tape or other similar delays in the office of the director. In most cases the reply could be made that delays were not occurring from these causes. This same condition existed under other directors and many of the delays that did occur were caused by civilian specialists.

The writer makes these statements from personal knowledge and because he feels that the pamphlet in question does not do justice to the Corps of Engineers, of which he has never been a regular officer.

It would appear that there are plenty of arguments for the proposed new department without reflecting on the excellent war record of the Corps of Engineers. The regulars made mistakes as did the volunteers and efforts should be made to improve the training of both the regulars and reserves rather than to restrict that of the regulars.

WM. G. ATWOOD,
St. Louis, Mo., Oct. 21 formerly Colonel of Engineers.

Sir—The writer was very much interested in your editorial on "Over-emphasizing the Corps of Engineers." At the beginning of the world war the writer held a reserve commission as captain in the Engineer Reserve Corps and was later transferred to the construction branch of the Quartermaster Corps and handled some $12,000,000 worth of construction, reaching the rank of lieutenant colonel.

The article was timely and very pertinent. The writer came in intimate and generally conflicting contact with the officers of the Corps of Engineers and was extremely surprised to find that as military engineers they were the finest that the world can produce but that their knowledge of commercial engineering was of the stereotype school-boy textbook and that they were woefully ignorant of engineering principles, due mostly to the fact that they did not have the experience and had not had the experience which commercial engineering only can give.

Even the high ranking officers with between twenty and thirty years commissioned service in the Corps of Engineers failed to grasp the progress of the time and appeared to have depended for their technical knowledge upon the civilian engineers from the civil service who were permanent fixtures in the different offices and who practically developed and handled all of the plans and details, leaving the commissioned officer as an executive without the primary knowledge which is so necessary under keen competition in present day commercial life.

I do not desire to condemn the Corps of Engineers as a whole but I do believe that it is very essential that either they should remain purely and strictly military engineers with troops or they should be given training and such experience in commercial engineering that when the next war breaks that they will be in a position to handle the entire construction program which is now required for mobilizing and concentrating an entire nation for war.

Either let us give our army engineers the experience of operating huge camps, water, sewer systems, steam heating plants, structural designs and construction and engineering as a whole or else let us make them purely engineers with troops and build up a branch of the army which will be trained and which can handle the commercial engineering so vital in this modern time to the essential winning of a big war.

FIDELIO G. CHAMBERLAIN,
San Antonio, Tex., Oct. 11. Consulting Engineer.

The Baltimore Centrifugal Pump Test

Sir — The caption, "Baltimore Pump Sets New Duty Record for Centrifugals," heading the article in your issue of June 2, p. 938, on the test of a 30-m.g.d. steam-turbine-driven centrifugal pump, challenges criticism, principally for two reasons:

1. That although the discharge was measured both by Pitot tube and by Venturi meter and the Venturi meter showed 3.5 to 4 per cent lower delivery than did the Pitot tube, the latter alone was, in spite of the generally recognized greater reliability of the Venturi, used in calculating the duty, and

2. That while on the basis of the Venturi measurements the overall efficiency of the turbine and pump was 53.8 per cent at the specified rating and 57.2 per cent at 50 per cent overload, a pump of about the same capacity tested at Toronto some six years ago showed an efficiency of 56.5 per cent at the load for which it was designed. The Baltimore pump can hardly, therefore, be said to set "a new duty record."

The unapproached trustworthiness of the Venturi meter arises from the fact that the conditions of flow are definitely determined by the construction of the meter, and if the tube is properly installed it should have exactly the same coefficient in use as when calibrated by the maker. The Venturi tube gives a large differential pressure, which is favorable to exact measurement. The form of the tube has not only been standardized by several makers, but the tubes of one maker differ so little from those of other makers that, in the large sizes here under consideration, their coefficients can be assumed almost with certainty to lie between 0.98 and 0.99.

The Pitot tube, on the other hand, is peculiar in that while the action of the impact tube itself agrees exactly with theory, in practical use Pitot tubes give rise to considerable error. The principal source of error is lack of knowledge of the relation between the velocity indicated by the tube in any given position and the average velocity over the whole cross-section of the pipe.

The results obtained with the Venturi tube have, in view of the consideration just presented, been used in the following analysis of the Baltimore test. For the 4-hr. test made at about the specified rating of 30 m.g.d. the values given are:

Steam pressure, lb. gage	174.34	
Superheat, deg. F	43.6	
Vacuum, in., referred to a 30-in. barometer	28.937	
Condensate pump discharge, lb. per hr	13,087.8	
Delivery of main pump, m.g.d.	30.43	
Total head, ft., including 3.01 ft. correction for velocity head	187.14	
Water horsepower	1,000	
Brake horsepower at pump shaft, estimated	1,252	
Pump efficiency, per cent	79.9	
Steam consumption, lb. per brake hp.-hr.	13,087.8 / 1,252	= 10.42
Steam consumption of a perfect turbine expanding steam between the terminal conditions given, lb. per hp.-hr.	6.9	
Rankine cycle efficiency of turbine, including gears, per cent.	66.2	
Overall efficiency of turbine and pump, per cent.	52.8	

The above-named efficiency includes the auxiliaries. As the steam or power consumption of auxiliaries may vary quite considerably for the many different types used, it would be interesting to know the overall efficiency of turbine and pump alone, which in this case can be very closely calculated with the information given.

In order to give the unit credit for the work consumed by the Pelton wheel driving the condensate pump, we can use the following figures:

Wheel nozzle pressure, lb. per sq.in.	117.4
Consumption of wheel, gal. per min.	61.6
Water hp. used	4.22

4.22 hp. is 0.422 per cent of the water hp. above credited to the main pump.

The water used by the hurling-water air pump amounted to 548 gal. per min. at 77.6 ft. head, or 10.7 water horsepower. Assuming the efficiency of the pump supplying this water, which is driven from the main unit, to be 65 per cent, the shaft horsepower becomes 16.5, which is 1.32 per cent of the shaft horsepower generated by the turbine.

In the published report no reference is made to the amount of steam withdrawn by the hurling-water air pump, and hence not accounted for in the condensate and not

charged against the turbine. A hurling-water air pump is really a high-velocity jet condenser and is in free communication with the vapor space of the main condenser. Such jet condensers are sometimes used to condense *all* the steam, as well as to remove the air, as in the well-known Schutte & Koerting low-level jet condenser.

The condenser friction may be estimated at 0.3 ft., which is 0.16 per cent of the head developed by the unit. We therefore have the total power consumption of the auxiliaries 0.422 + 1.32 + 0.16 = 1.9 per cent, and 1.019 × 0.528 = 53.8 per cent as the overall efficiency of turbine and pump. Using 66.2 per cent as the efficiency of the turbine and gears, this gives a centrifugal pump efficiency of 81.3 per cent.

In the test at 50 per cent overload, the duration of which was 1 hr. only, the following results were obtained:

Steam pressure, lb. gage	173.38	
Superheat, deg. F	53	
Vacuum, in Hg., referred to 30-in. barometer	28.955	
Condensate pump discharge, lb. per hr	17,282	
Main pump discharge, m.g.d.	44.87	
Total head, ft., including 6.51 ft. correction for velocity head.	180.16	
Water, hp	1,419	
Brake hp. at main pump shafts, estimated	1,701	
Pump efficiency, per cent	1,419 / 1,701	= 83.45
Steam consumption per brake hp.-hr.-lb.	17,282 / 1,701	= 10.16
Steam consumption of a perfect turbine for the same terminal conditions, lb. per hp.-hr.	6.84	
Rankine cycle efficiency of turbine, including gears, per cent	6.84 / 10.16	= 67.4
Overall efficiency of turbine and pump, per cent	56.2	

For making similar corrections as before for power used by auxiliaries we have:

Pelton wheel nozzle pressure, lb. per sq.in.	108.9
Water used by Pelton wheel, gal. per min.	59.5
Water hp.	3.78
Total head on hurling water supply pump, ft.	89.3
Water used by hurling-water air pump, gal. per min.	591

Assuming 65 per cent efficiency of the pump which supplies the hurling water, this gives a brake horsepower of 20.5.

Assuming condenser friction to be 0.6 ft., we have as the percentage power consumption of the auxiliaries 0.266 + 1.2 + 0.333 = 1.8 per cent and the overall efficiency of turbine and pump alone 0.562 × 1.018 = 57.2 per cent, which, assuming 67.4 per cent turbine efficiency, gives a pump efficiency of 84.85 per cent.

This performance is obtained at 50 per cent over the rating specified, but this maximum capacity can probably be taken advantage of for short periods only, as it imposes a 50 per cent overload on the gears.

For comparison, figures may be taken from the official test of one of the De Laval pumps at Toronto, referred to above, designed and built some six years ago, since which time material improvements have been made in the efficiency of both turbines and pumps. The official acceptance test was made and reported by Prof. Robt. W. Angus, of the University of Toronto, acting for the city.

The test extended over 24 hours. The steam pressure was 144.6 lb. gage and the steam contained 0.35 per cent of moisture, but no correction was made for this moisture. The vacuum was 29.27 in. The capacity developed was 20,900 gal. per min. against 252.57 ft. head, corresponding to a water horsepower of 1,333. This was the normal rating of the unit, and is about 10 per cent less than the power developed by the Baltimore pump in the test showing the highest duty. The duty, excluding auxiliaries, was 160,500,000 ft.lb. per 1,000 lb. of steam. The steam consumption per water horsepower was 12.34, while the steam consumption of a perfect turbine and pump working between the same terminal conditions would be 6.97 lb. per hour, giving an overall efficiency of turbine and pump of 56.5 per cent.

DE LAVAL STEAM TURBINE CO.,
Trenton, N. J., Aug. 8. Per A. PETERSON.

Sir—In the foregoing letter, Mr. Peterson claims, among other things, that a Venturi meter is a more accurate instrument for the measurement of water than a pitometer. The accuracy of the results obtained with either instrument depends upon care taken in calibration and observation.

The Baltimore contract specified that the water measurements should be made by two Pitot tubes, one placed in the suction and the other in the discharge line of the pump. Extreme care was taken to make an accurate traverse of the pipe lines. A pilot Pitot tube was used to insure all traverse readings being taken at the same capacity. The small variation in the readings of the two instruments is evidence of the accuracy of the results obtained.

The Venturi meter was read during the test for the convenience of the city, and for the purpose of ascertaining its approximate percentage of error. It was not calibrated; no manometer was used; the readings were taken from the dial and were not used in the calculation of results.

The suggestion is made that the duration of the test was not sufficient to assure accurate results. Providing a pumping unit has been running under contract conditions for a period sufficient to allow the flow in pipe lines to become stabilized, a carefully conducted test of one hour on this type of pumping unit will show the actual duty within a very small fraction of 1 per cent.

The tendency of an air pump to steal steam depends entirely upon the manner in which it is connected and the relative size of the condenser and pump. The conditions were such at Baltimore that the amount of steam removed by the air pump and unaccounted for was negligible. This is evidenced by the temperature of the water in the well into which the air pump discharges.

I do not agree with Mr. Peterson that the performances of pumping engines should be compared on the basis of disregarding the power required for the condenser auxiliaries. Excellence of design resulting in economical performance of the condenser and its auxiliaries should be considered in determining the efficiency of a complete pumping engine. The comparison of the performance of the Toronto and Baltimore pumps should, therefore, be made on this basis.

The final test of the Toronto pump was published in *Canadian Machinery*, Dec. 27, 1917. Prof. Angus of Toronto University gives the duration of the test as 10 hr., not 24 hr. At point of normal operation the test was run for 4 hours.

The quality of the steam at Toronto and Baltimore was somewhat different. The proper manner to compare the performance of these two pumps is on the basis of available heat. The mean available heat on the two tests at Toronto was approximately 380.45 B.t.u., the difference between the two tests being very slight. The average available heat on the tests at Baltimore was 386 B.t.u., the difference in these tests also being very slight. This means that the unit at Baltimore had available 1½ per cent more heat than the unit in Toronto. Prof. Angus' report gives a duty of 150.92 for one unit and a duty of 153.92 for the other unit. Allowing a 1½ per cent increase in duty for difference in steam conditions, this would give a duty of 153.2 m.ft.-lb. for the first, and 156.2 m.ft.-lb. for the second Toronto unit. The Baltimore pump developed a duty of 160.2 m.ft.-lb. at contract capacity and 170.2 m.ft.-lb. duty per 1,000 lb. of steam at excess capacity.

It is suggested that the higher duty obtained on the Baltimore pump at excess capacity should be disregarded, as it is of no value to the city. On the contrary, the Baltimore pump, since its installation, has operated for considerable periods at a capacity of approximately 40 m.g.d. Its excess capacity was considered by the city to be of such value that it was deemed undesirable to make slight alterations on the pump which would have resulted in its maximum performance being obtained at the contract capacity.

The Toronto tests were made March 6 and 8, 1917, with undoubtedly very low temperature condenser cooling water. The Baltimore test was made Aug. 4 and 6, 1920. The temperature of the condensing water was slightly over 70 deg. F.

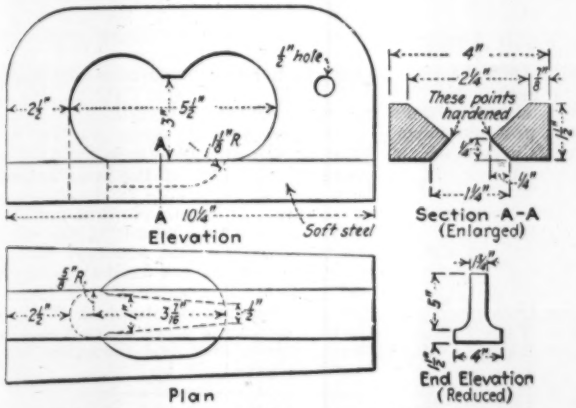
From the facts given above it is apparent that both under contract conditions and under excess capacity conditions, the performance of the Baltimore pump substantiates the statement appearing in *Engineering News-Record* of June 2, entitled "Baltimore Pump Sets New Duty Record for Centrifugals."

ROBERT W. ALLERTON,
New York City, Worthington Pump & Machinery
Sept. 30. Corporation.

HINTS FOR THE CONTRACTOR

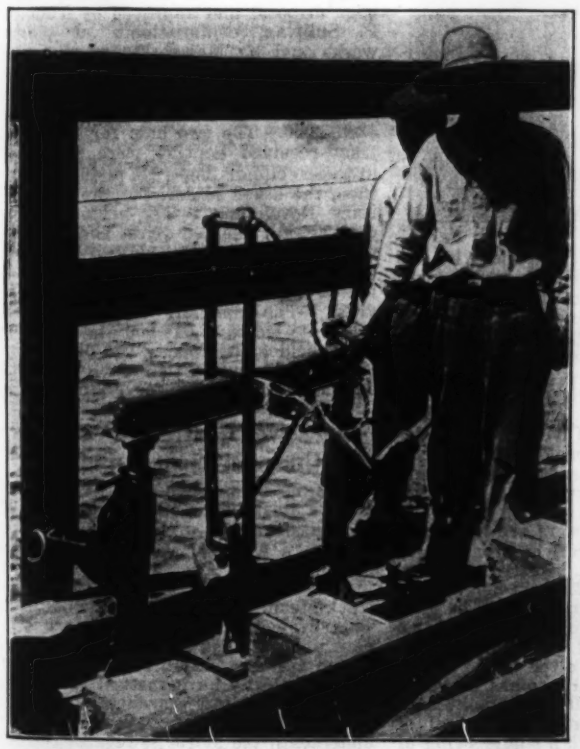
Drift-Bolt Puller Speeds Renewal of Lucin Trestle Deck

IN RENEWING the deck on 11.8 miles of the Lucin cutoff trestle on the Southern Pacific R.R., an average of about 4,600 drift bolts per mile have to be pulled. Due to natural conditions the bolts which are ¾ x 25 in. in size, galvanized, have "frozen" very firmly into the wood and when the work started were removed only



THE CLAW THAT GRIPS THE TOP OF THE BOLT

with great difficulty by clawbars or other ordinary methods.



DEVICE RAISING A DRIFT BOLT FROM THE STRINGER OF A TRESTLE DECK

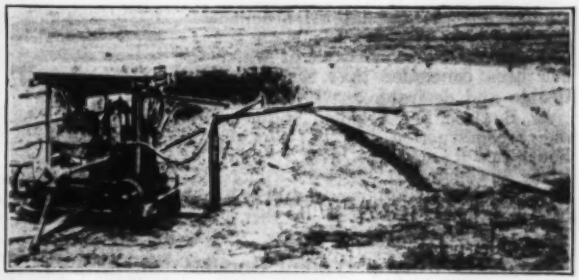
A device was therefore developed by the maintenance of way forces and constructed in the shops at Ogden with which the bolts are now being removed speedily and easily.

The first operation is to adz away the top of the stringer to a depth of an inch or more entirely around the bolt and for a distance of 5 or 6 in. each way. A steel claw, shaped as shown in the accompanying drawing, is then placed over the bolt and tapped with a sledge so as to drive it horizontally and cause the narrowing edges of the claw to bite into the bolt.

A "lifter" or clevis-like device is attached to the puller and by the use of two jacks and a short piece of rail, as shown in the accompanying illustration, the puller is raised vertically, bringing the bolt with it. The jacks stand on the stringer itself, so there is no tendency to pull the stringer away from the cap. The ropes shown in the illustration are to prevent the several pieces from falling into the lake in case of any slip.

Storage Reservoir Insures Constant Water Supply on Road Work

ON CONCRETE road work near Garden City, Kan., where daily runs of over 800 ft. of 16-ft., 7-8-7-in. section pavement, have been made, a storage reservoir has been found a useful regulator of a water supply taken from a deep well. The road passes through a stretch of country 2½ miles from the nearest place where water can be secured. A concrete reservoir, as



CONCRETE LINED STORAGE RESERVOIR FOR ROAD WORK

indicated by the illustration, was built ½ mile from the well, and from the reservoir the water is pumped 2 miles to the paving mixer. One pump, a 4-cylinder, triplex, portable outfit, pumping alternately from well to reservoir and from reservoir to mixer, is employed. During working hours the pump supplies the paver, and on Sundays and at night it fills the reservoir. The reservoir is about 40 ft. in diameter and the concrete lining is 6 in. thick. The contractor is the Ammerman Contracting Co., Garden City, Kan., which has a contract for 28 miles of pavement.

The information contained in this note was supplied by the Chain Belt Co., Milwaukee, some of whose equipment was used on this job.

NEWS OF THE WEEK

New York, November 10, 1921

Delaware River Bridge Plans Taking Definite Form

The plans for the caissons and masonry of the two river piers of the Delaware River Bridge are practically complete. Plans and the contract were brought up for adoption at the meeting of the joint commission on Nov. 9 and it is expected that bids will be advertised for within a couple of weeks after that date for tenders to be received toward the end of December. These piers will measure 70 x 143 ft. at the base and will require for both some 62,000 cu.yd. of masonry. They will be granite faced down to a point below low water level. The borings at the site of the two piers are practically complete and show rock at from El. —58 to El. —73 on the Philadelphia side and from El. —80 to El. —90 on the Camden side. The boring contractor will now move to the sites of the anchorages.

Formal approval to the plans for the bridge was given by the Secretary of War and Chief of Engineers, U. S. Army, Sept. 26, 1921. The plans were submitted in accordance with the results of the hearing of last February, when it was concluded that a clearance of 135 ft. above mean high water and a span with piers outside the pierhead lines, would be acceptable.

Notices of condemnation have been served on owners of property at the sites of the river piers and anchorages. The joint commission has authority to enter on such properties and commence work within sixty days after serving notice.

An investigation of the feasibility of eliminating the top lateral bracing in the stiffening truss of the main spans has been made, as a result of which it has been concluded that this is practicable and desirable.

M. B. Case, now resident engineer on the reconstruction of the Cincinnati Southern Ry. bridge over the Ohio River at Cincinnati, has been appointed senior resident engineer and will have full charge of the work in the field.

Technical Unemployment Small

Records of the American Association of Engineers show that unemployment among professional technical men is small as compared to the trades. Roughly estimated about 2 per cent of the technical men are actually unemployed.

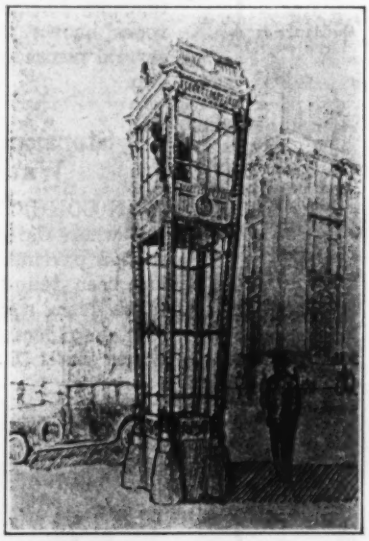
The Employment Bureau of the Association is planning a further development of its employment service to professional technical men. The plan contemplates establishing offices in at least eight employment centers to act as clearing houses for different sections of the country. During the year ending Sept. 30, 1921, notices of 6,165 positions open were sent to all members of the association that asked to receive them. There were 3,018 men placed, 1,824 through the Chicago office and the remainder through the branch offices. The annual saving to the members affected exceeded $300,000.

Highway Bill Goes to President

Those who were disposed to withhold unanimous consent for the consideration of the conference report on the highway bill in the Senate, following its recent approval by the House of Representatives, finally were induced to allow the report to come up and it was approved without debate and hurried to the White House. In the regular course President Harding referred it to the Secretary of Agriculture for his recommendation.

Select Design for Fifth Avenue Traffic Signal Towers

Final selection of a design for the five permanent traffic signal towers which are to replace the present temporary structures on Fifth Ave., New York City, has been announced by the Fifth Avenue Association, which is to present the towers to the city. Joseph H. Freedlander, a New York Architect, submitted the design which was unanimously adopted, in competition with 129 others, as the most practical as well as the most appropriate to the dignity and beauty of Fifth Ave. In addition to the cash prize of $500, Mr. Freedlander will be retained by the association as architect to prepare the working drawings and supervise the construction of five towers.



The new signal towers are to be constructed almost entirely of bronze, with a granite base 4 ft. square and 3 ft. high. They will be 23 ft. in height. The lower part of the structure will be open so as to allow an unobstructed view up and down the avenue. The space at the top, which is to house the traffic policeman, will be enclosed in glass windows, so operated as to allow the policeman in the tower to open or close all of them at one time with a single swing of a lever. The tower base, as shown in the illustration, is subject to modification.

Fire Destroys Four Erie Piers Causing $2,000,000 Loss

Fire of an unknown origin, starting about midnight November 3, completely destroyed four ship piers at Weehawken, N. J., belonging to the Erie R. R., and caused other property damage variously estimated at from $2,000,000 to $4,000,000. Loss sustained by the Erie R. R. alone amounted to $2,000,000, of which $500,000 was in merchandise stored on the piers and in box cars lying in the adjoining yards, the remainder of the loss being sustained through the destruction of the four piers, and the destruction of and damage to 22 barges and lighters and a string of seventeen freight cars.

Plans are already under way for rebuilding the piers, a meeting of the board of directors of the road having been held last Tuesday to decide upon some plan. It is possible that but one of the piers will be rebuilt at the present time, though that one may be entended out to the pier-head line, which will give much greater length to the new pier than the old ones had. Two of the four destroyed piers, Piers A and B, were built in 1882 and the other two, C and D, were built in 1891.

Boston Advised to Accept Bid of $3,795,000 for Garbage Disposal

The city council of Boston will hold a hearing Nov. 16 on the recommendation made by the special committee on garbage disposal and approved by Thomas P. Sullivan, commissioner of public works and by Mayor Peters that the contract for garbage disposal for the ten years beginning July 1, 1922, be awarded to Coleman Bros., Inc., for $3,795,000. The two bids for this contract received Sept. 7 were published in these columns Sept. 15, p. 465. Since then, the other bidder, the Boston Sanitary Development Co., holder of the contract for the ten years now ending, notified the city that owing to improved conditions it could do better than its bid of $4,202,000. New bids were invited. The company last named reduced its bid to $3,914,000 and Coleman Bros. held to its former bid of $3,795,000. It is expected that the award will be made the subject of several hearings.

Big Sewer Contract To Relieve Unemployment at Dallas

In order to improve employment conditions at Dallas, Texas, the Board of Commissioners is preparing to ask for bids on a $300,000 storm sewer to be built in Pacific Ave., a street that has just recently been freed from a double-track steam railway and switch tracks. This project is one of the large city plan undertakings and is the first step in the transformation of a street that was practically an industrial route into a first-class retail thoroughfare. It is planned to place a large sanitary sewer underneath the storm sewer. Engineers are watching this project as the problem of handling the excavation will be unusual on account of earth conditions.

Logging Engineers in Convention at San Francisco

Problems involved in logging engineering occupied the most prominent place among the topics discussed at the twelfth annual Pacific Logging Congress, held at the Palace Hotel, San Francisco, Oct. 26-29. One session was devoted to discussion of standardizing courses of study preparation for the profession of logging engineering. Four colleges which have been offering courses in forestry and logging engineering were represented by graduates. These schools are the Universities of California, Washington and Idaho and the Oregon Agricultural College. Among the several hundred delegates in attendance were representatives of logging interests from eight states and British Columbia. Some of the papers which were more particularly within the engineer's field were as follows:

"A Standard System for Management of Camp Mess-Houses," by W. C. Ruegnitz, Portland, Ore.; "Utilizing Flumes for Handling Pacific Coast Timber," by A. P. Allison, Brooks-Bidlake & Whittall Co., Ltd., Vancouver, B. C.; "Logging With Motor Trucks in California Pine District," by A. M. Mortensen, Manager, California Fruit Exchange, Graeagle, Cal., "Motor Trucks in Douglas Fir Logging," by J. P. Van Orsdel, Portland, Ore.; "Camp Building," by James O'Hearne, English Lumber Co., Mt. Vernon, Wash.; "Intensified Railroad Construction Versus Donkey Hauls," by L. T. Murray, West Fork Logging Co., Tacoma Wash.; and "Steam Shovel in Logging Railroad Construction," by Minot Davis, Clemons Logging Co., Montesano, Wash.

Officers elected for the ensuing year were: President L. T. Murray; vice-President, James O'Hearne; and secretary-treasurer George M. Cornwall, Portland, Ore.

Mechanical Engineers Plan Annual Meeting Dec. 5-9

Elimination of industrial waste will be stressed at the annual meeting of the American Society of Mechanical Engineers to be held in New York City Dec. 5-9. The report of the Committee on Elimination of Waste in Industry of the American Engineering Council will provide the basis for the discussion. The leading session will point out the necessity for waste elimination and develop essential principles of standardization and stabilization. The professional sections will consider in technical fashion the steps that can readily be taken more effectively to utilize our national resources.

Two sessions on education will be held, one under the auspices of the Committee on Education and Training in the Industries, and the other a joint meeting with the Society for the Promotion of Engineering Education. A new development in annual meeting projects will be launched at the December convention. The Committee on Relations with Colleges has charge of a session at which the papers will be prepared and presented by students. Discussion will be limited to students and the meeting will be conducted by students.

The honorary memberships which have been granted to Henry R. Towne and Nathaniel G. Herreshof will be formally bestowed on the evening of Dec. 5, following the address of President Carman. The business meeting has been scheduled for Dec. 7. The entire day will be given over to the discussion of the policies of the society and especially of the new constitution.

Federal Road Bureau Starts New Research Program

Will Study Wavy Surfaces, Bridge Impact and Effect of Vibration On Subgrade Moisture

The U. S. Bureau of Public Roads is preparing to undertake a number of new experiments, including an investigation to determine the cause of wavy road surfaces, a study of the warping of concrete road slabs as a result of temperature changes, an experiment to determine the effect of slab vibration upon the movement of moisture in the subgrade, a study of impact stresses in bridges and other frame structures, and a large-scale experiment to test various designs of concrete surface sections.

The study of the cause of wavy road surfaces will be made on a circular track 15 ft. wide and 180 ft. in diameter, which is being built at the Arlington Farm, just outside of Washington, D. C. The circumference of the circle will be divided into sections, each of which will be surfaced differently with various kinds of tar and asphalt pavement, some of them on concrete bases. The "traffic" to which these sections will be subjected will be supplied by a driverless motor truck, which will be held to the circular path by means of a long arm extending from the center. By a simple device the course of the truck will be altered from time to time so that the entire width of the roadway will be traveled over. It is not likely that the actual experimental work will be begun until next season.

New Impact Device

The study of impact stresses in bridges will be made with a new instrument devised in the bureau and now practically perfected. Attached to any member of the bridge the instrument makes a photographic record of the effect of a moving load. The deformation resulting from the impact is represented by a fine line on the photograph. From the preliminary tests which have been made it appears that the results of the quickest blows are measured by the instrument. It is now being calibrated and will shortly be put into use to obtain experimental data.

The experiments on concrete sections will be made on the Columbia road in Arlington County, Va., and the cost of the construction will be shared by the county. Only a part of the road will be used for experimental purposes. Various sections will include surfaces with different kinds of joints, some with longitudinal joints and some without. Some will be built with gravel sub-bases; others will be built over especially treated subgrades in which the soil will be mixed with cement for a depth of 6 inches, using 1 part of cement to 20 parts of earth. Of special interest will be the various forms of ribbed sections and the various arrangements of different kinds of reinforcing material. The road is now under construction, but it will not be completed until next season. The various surfaces will be subjected to normal road traffic, the weight and volume of which will be determined by careful traffic counts.

Railroad Executives Will Press Wage Cut Action

Railroad executives of the eastern roads will endeavor to secure from the Railroad Labor Board authorization for a further reduction in the pay of operating employees, so that the 20 per cent increase put in effect during 1920 will be written off. The 12 per cent cut ordered in July has written off part of that increase. Conferences with employees are to start within a few days and when a concrete plan has been evolved it will be put before the Railroad Labor Board. As that body secured a recall of the strike order, scheduled to go in effect Nov. 1, on the basis of no further wage reductions being ordered, it is doubtful that any immediate action by the board will be forthcoming.

California County Engineer Act Held Unconstitutional

The supreme court of the State of California recently rendered an opinion declaring unconstitutional the Ream bill passed at the 1919 session of the California Legislature which created the office of county engineer, leaving it to the board of supervisors in each county to fix the salary of the office. The legislation was popularly known as the California County Engineer Act. The act stated that the "county engineer shall be deemed an employee and not a county officer."

A number of counties with extensive work under way handled by well-organized county engineering staffs now face the situation of having no authority to pay the county engineer's salary. Some of these salaries are $5,000 to $6,000 per year in counties where the salary of the county surveyor, fixed by the legislature, is limited to $3,200, with not more than one deputy at not more than $85 per month.

The supreme court decision holds that the act "violates the constitutional requirement that the system of county government . . . shall be uniform throughout the state."

To Study Properties of Steel Reinforcing Bars

Announcement has been made by the American Society for Testing Materials that a special committee has been appointed to conduct an investigation of the physical properties of plain and deformed concrete reinforcement bars. The personnel of the committee is: E. E. Hughes, Franklin Steel Co.; Richard L. Humphrey, consulting engineer; A. E. Lindau, Corrugated Bar Co.; C. F. W. Rys, Carnegie Steel Co.; W. A. Slater, Bureau of Standards, and J. J. Yates, Central Railroad of New Jersey.

The primary object of the investigation is the study of physical properties of steel reinforcement bars,—plain, deformed and twisted,—rolled from the four different grades now in commercial use, tested in the form as rolled and as machined specimens. The data obtained will serve as a basis for possible revisions of the society's specifications for reinforcement bars. The investigation will have a direct bearing upon the work of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete. This committee has suggested an extension of the scope of the investigation to include a study of the efficiency of de-

formed bars when used as reinforcing in concrete, with special reference to the effect of the design of the bar on its bond resistance.

Sanitary Engineers at Public Health Convention

Besides the general sessions of the fiftieth annual convention of the American Public Health Association at the Hotel Astor, New York City, Nov. 14-18, there will be various section meetings, including sanitary engineering, laboratories, public health administration, vital statistics and others. On the afternoon of Nov. 16, the sanitary engineering section will meet jointly with the American Society of Civil Engineers at the United Engineering Societies Building, where the program will be on stream pollution and sewage disposal.

The first session of the sanitary engineering section of the A. P. H. A. will be held Tuesday afternoon, Nov. 15, when there will be an address by the chairman, S. A. Greeley, consulting engineer, Chicago. The Thursday morning session will listen to a report of the committee on water supply and purification, George W. Fuller, chairman; a report of the committee on sewerage and sewage treatment, Kenneth Allen, chairman; and other papers.

Two subsequent sessions will take up the sanitation of bathing places, beaches, and swimming pools; mosquito extermination; milk pasteurization; and city zoning in relation to health. There will also be presented the report of the committee on garbage and refuse disposal, M. N. Baker, chairman.

Am. Soc. C. E. To Hold Conference on Sanitary Engineering

In recognition of the fiftieth annual convention of the American Public Health Association, in New York City, the American Society of Civil Engineers has arranged for a general conference on sanitary problems to be held Nov. 16 and 17 at the Engineering Societies Building, New York City. All interested in sanitary engineering problems are invited to attend, particularly members of the sanitary engineering section of the A. P. H. A. The general conference will have sessions at 2 and 8 p.m. Wednesday, Nov. 16, and at 8 p.m. Nov. 17.

The first of the three sessions will be devoted entirely to stream pollution and sewage disposal, with papers by George T. Hammond, Brooklyn; Kenneth Allen, New York; John F. Skinner, Rochester, N. Y.; W. L. Stevenson, Harrisburg, Pa.; Earle B. Phelps, New York City; Paul Hansen, Chicago; W. H. Dittoe, Columbus; and Langdon Pearse, Chicago.

The second session will be given up to discussions of odors by George C. Whipple, Harvard University; Stephen DeM. Gage, Providence, R. I.; I. S. Osborn, Cleveland; Andrew J. Provost, New York; and Robert Spurr Weston, Boston.

Water supply and water purification will be the subject of the third and final session. The speakers will be Prof. Whipple; Allen Hazen, New York; C. A. Emerson, Jr., Harrisburg, Pa.; C.-E. A. Winslow, Yale University; C. A. Holmquist, Albany; Robert Spurr Weston, Boston; and Samuel A. Greeley, Chicago.

American Road Builders Plan Annual Meeting

The annual meeting and dinner of the American Road Builders' Association will be held at the Automobile Club of America, New York City, Nov. 15. In the afternoon the officers will render their reports and in the evening the dinner will be held, after which the incoming president and other officers for the ensuing year will be installed, followed by speeches by members of the association. One of the matters to be considered is the coming convention and good roads show of the association to be held at the Coliseum, Chicago, Ill., Jan. 16-20.

State Highway Policies on Fall Lettings of Contracts

These statements of policy on the fall letting of highway contracts supplement others published in recent issues of "Engineering News-Record":

South Dakota—"The highway commission in October awarded five contracts amounting to $232,000 for grading, culverts and bridges on 61 miles of road, and nine contracts amounting to $230,000 for gravel surfacing on 106 miles of road already graded.

"On account of the weather, grading work cannot, in general, be economically done in this state during December, January and February, so our field organization is put in the office during these months preparing plans for work to be let during the months of March, April and May. It is, therefore, expected that the major portion of our next year's work will be under contract by May. Plans are being made anticipating that pending legislation in Congress will provide additional funds."—*By F. D. Hudgins, State Highway Engineer.*

Colorado—"I am heartily in accord with the principle of letting contracts in the fall, so that the preliminary work can be got out of the way during the winter, and the contractors can be ready to begin active construction as soon as the season permits.

"There are practical reasons, however, that prevent any further letting this fall. Our yearly budget is made up in December, hence the estimated allotment to various projects is not known till then. Furthermore, we are depending upon the sale of a $3,000,000 bond issue to finance the state's proportion of federal-aid projects covered in the 1922 program. This sale cannot take place until June, 1922, and hence we will not know till then whether or not the funds are available.

"We hope to get matters adjusted so that our financial program will be more harmonious with elements that affect an efficient construction program."—*By L. D. Blauvelt, State Highway Engineer.*

Washington—"The policy of letting contracts in the late fall or early spring has been pursued for some time in so far as the same is consistent with conditions and with the availability of funds. The funds for highway work in this state are provided through legislative appropriation. In order to take full advantage of the funds available in the matching of federal aid we are at this time awaiting on federal aid before letting any considerable amount for the next season.—*By James Allen, Supervisor of Highways.*

Contract Let for Tunnel Work on Skagit River Development

After several months of delay, waiting for lower prices, the Seattle Board of Public Works has let the contract for the Gorge Creek tunnel of the Skagit River development. The successful contractor is R. O. Storrie and Co., San Francisco, that firm's bid being $2,203,865. The Puget Sound Bridge & Dredging Co. was next lowest and Grant Smith & Co., both of Seattle, third.

The Gorge Creek project involves about a mile of open-cut excavation, a main tunnel two miles long, and the construction of a surge tank and riser necessitating the excavation of about 10,000 cu.yd. of material.

London Subway Extensions Planned

London Correspondence

The London Underground Railways have submitted to the Cabinet their application involving £8,000,000 new capital for the immediate carrying out of their extension plans. These plans include the extensions of several of the existing subways, the linking up of others and the enlarging of the oldest "tube" so as to accommodate the standard subway rolling stock. Parliamentary powers for these projects have already been obtained, full plans of the operations have been prepared and much of the preliminary work is in hand. The enlarging on the old City and South London "tube" is not to interfere with subway operations, so that work will be done between midnight and 4 or 5 a. m. At the estimated rate of progress of one foot per hour, this project will take two years to complete and will cost £2,000,000.

Reduced Salary Scale for Navy's Technical Personnel

Reductions in pay approximating 10 per cent have been applied to the technical service of the Navy, as well as to other civilian employees in the Naval establishment. Some of the items recommended by the Navy wage board and approved by the Secretary of the Navy for the technical service are as follows:

Steel superintendents, $10,000 per year; melt-shop superintendents, $5,000; machine-shop superintendents, $5,000; heat-treatment superintendents, $5,000; forge superintendents, $5,000; senior educational advisers, $6,500; plant engineers, $5,000; powder experts, $7,500; assistant to powder experts, $3,000.

In addition, numerous technical positions are rated on a per diem basis. Civil-engineering aids are to receive from $12.08 to $8.72, specification aids $9.04 structural aids from $10.96 to $7.60 and technical aids $7.68. Construction inspectors are scheduled at from $9.44 to $4.88, and creosote inspectors at $6.40. Naval construction inspectors are to receive $10.56 while their assistants are rated at $6.88.

Structural steel inspectors are to receive from $8.32 to $6.40 and timber inspectors from $8.32 to $5.68. The title of surveyor has been abolished and these positions re-rated as instrument men; the salary scale ranges from $8.24 to $5.36.

In the drafting service some of the new rates per day are: Chief draftsman, $13.20 to $14; draftsman, grade A, $6.80 to $7.60; draftsman, grade C, $4.48; copyist draftsman, $4.16.

To Study Paving Brick Standards

Elimination of excess varieties and styles in paving brick is to be considered at a meeting Nov. 15 in Washington under the auspices of the Secretary of Commerce. The meeting is to be open to all interested. A preliminary survey of tthe situation is being made by a committee of paving brick manufacturers and a report will be submitted setting forth the facts as to the volume of the manufacture in the various sizes and styles of bricks now in use.

Colorado River Hearing Planned

It is announced from Washington that the Secretary of the Interior and the Director of the Reclamation Service expect to hold a hearing in San Diego, Cal., on Dec. 1, in regard to the Colorado River problems. At this hearing the report of the Reclamation Service, in which has been assembled all available data bearing on the Colorado River, will be considered and the general question of the development of the river for irrigation, power, and flood prevention purposes will be taken up.

Back to Atlantic City

For many years the American Society for Testing Materials held its annual meetings at Atlantic City in June. In 1920, however, the rising cost of living at that resort led to holding the meeting at its minor rival sea-shore city, Asbury Park, and the experiment was repeated this year. The attractions of Atlantic City, however, still linger in the minds of the members, far by popular vote, confirmed by the executive committee, that place is selected for next June's meeting. Of the 502 votes cast, 229 were for Atlantic City, 135 for Asbury Park, and 49 for Chicago. The referendum also has led to a consideration of a plan for holding the annual meetings in the different places in succeeding years.

Complete Bar Survey at Entrance to San Francisco Bay

The survey of the bar just outside the entrance to San Francisco harbor has been completed under the direction of the Engineer Corps, U. S. A. and the report and recommendations of Colonel Herbert Deakyne Engineer Corps, U. S. A., who is stationed at San Francisco, have been submitted to Washington headquarters together with tabulated soundings and maps.

It is understood that Colonel Deakyne's recommendations include an estimate of the amount of work that should be done and its cost.

Of the two best channels in the approach to the Golden Gate from the sea, the so-called Bonita channel has ample depth but follows the rugged and somewhat irregular shoreline to the north, while the route directly across the bar in midstream is not deep enough for the largest ships. Improvement has been urged by the bar pilots association, by shipping interests and by the navy department, and it is believed that a channel 45 to 50 ft. deep and one-half mile wide could be constructed with sea-going dredges at comparatively low cost which, when constructed, would probably retain approximately the original dimensions.

Forestry Investigation Continued

The committee on forestry policy of the Chamber of Commerce of the United States will hold its hearings in New Orleans Nov. 14, 15 and 16 as a continuation of its investigation of forestry conditions throughout the country. This committee was appointed to recommend to the United States Chamber a national forestry policy. Similar hearings have been held throughout the Middle West and Pacific Coast states.

Irrigation District Wins in Court

The Kennewick Irrigation District, at Prosser, Wash., has won a victory in the Benton County Court throngh a decision, rendered by Judge Mills, sustaining the irrigation district's claim that the need of water for irrigation purposes is superior to the requirements of a flour mill, electric plant and other private interests involved, for which reason he granted an order of necessity and permitted condemnation of the Prosser Falls dam. About 35,000 acres of irrigable land will be benefited by the proposed ditch. Compromise negotiations now under way contemplate preserving ample power to operate the flour mill and electric power plant.

Two-Day Discussion on Joint Committee on Concrete Report

Two days, with three sessions each day, will be devoted to a discussion of the report of the Joint Committee on Concrete and Reinforced Concrete by the American Society of Civil Engineers, on Dec. 7 and 8, in the Engineering Societies Building, New York City. Portions of the report, which consists of tentative specifications for concrete and reinforced concrete, will be discussed as follows

Dec. 7, 9 a. m. Chapter IX. Waterproofing and Protective Treatment.
Chapter X. Surface Finish.
2 p. m. Chapter VI. Depositing Concrete.
Chapter VII. Forms.
Chapter VIII. Details of Construction.
8 p. m. Chapter XI. Design
Dec. 8, 9 a. m. Continuation of discussion of Chapter VIII and X.
2 p. m. General discussion of the Tentative Specifications for Concrete and Reinforced concrete and of the scope of the Joint Committee's work.
8 p. m. Chapter III. Quality of Concrete.
Chapter IV. Materials.
Chapter V. Proportioning and Mixing Concrete.

Cleveland Adopts Manager Plan

Early returns indicate the adoption of the city-manager plan at Cleveland, Ohio, Nov. 8, by a large popular majority. The manager will be appointed by a city council of 25 members, elected from four districts on the proportional representation plan, to take office Jan. 1, 1924.

I. C. C. Reports Tentative Value of Rock Island

The final value of the property of the Chicago, Rock Island and Pacific Railroad, devoted to common carrier purposes, on lines wholly owned and used by the company, has been found to be $251,809,983 in the tentative valuation report which just has been issued by the Interstate Commerce Commission. The value of the property used but not owned by the parent company was found to be $70,467,613. In addition, the company owns and has under lease property valued at $252,937.

The cost of reproduction (new) on the lines wholly owned and used by the parent company was found to be $250,697,172. The cost of reproduction (less depreciation) is reported as being $197,090,275.

The outstanding capitalization of the company, at the time of the valuation, was found to be $307,287,422.50. Information of the same character for the affiliated lines of the Rock Island system is shown in the accompanying table.

Name of Road	Final Value	Cost of Reproduction New	Cost of Reproduction Less Depreciation	Outstanding Capitalization
Keokuk & Des Moines Ry. Co.	$3,464,958	$3,269,803	$2,592,509	$6,875,000 00
Choctaw, Oklahoma & Gulf Railroad Co.	35,500,000	39,406,828	30,800,082	31,692,981 93
Rock Island, Arkansas & Louisiana R.R. Co.	10,750,000	11,781,218	9,884,803	15,214,321 73
St. Paul & Kansas City Short Line R.R. Co.	8,400,000	7,933,931	6,967,280	12,679,044 63
Rock Island & Dardanelle Ry. Co.	215,000	230,800	198,549	200,000 00
Rock Island, Stuttgart & Southern Ry. Co.	213,000	217,976	169,052	490,266 22
Rock Island Memphis Terminal Ry. Co.	700,000	261,871	261,871	1,438,459 94
Peoria and Bureau Valley R. R. Co.	1,650,000	1,607,220	1,318,717	1,500,000 00
White & Black River Valley Railway	700,000	787,355	630,714	1,000,000 00
Chicago, Rock Island & Pacific R.R. Co., (Iowa Co.)	23,250	19,194	14,732	227,500 00
Chicago, Rock Island & Gulf Ry. Co.	13,833,406	14,960,839	11,974,731	17,248,372 60
Morris Terminal Railway Co.	48,750	59,908	42,902	52,207 39

Tulsa Gets Report on Gravity Water Supply From Ozark

For an estimated cost of $6,800,000, Tulsa, Okla., can get a 25-m.g.d. gravity water supply from Spavinaw Creek in the Ozark foothills, according to a report presented Oct. 24 to the Non-Partizan Water Commission by J. D. Trammell and W. R. Holway, consulting engineers. The plan calls for a 55-ft. dam on Spavinaw Creek impounding 16 billion gallons, or more than a year's supply, and a 55-mile conduit—28 miles of 60-in., 27 miles of 48-in.—conducting the water by gravity to a point five miles from Tulsa, where a high pressure pumping station would lift the water 300 ft. through a 30-in. cast-iron pipe to a high pressure distribution reservoir holding 30 days' supply on the edge of the city 4½ miles distant. At this reservoir the water would be aerated and chlorinated.

The estimated costs are: Dam, $1,132,000; conduits and right-of-way, $4,065,150; tunnel, $225,000; reservoir and pump station, $458,000; distribution mains, $541,000; engineering and supervision, $321,057; administration, $57,793.

The water commission has issued a call for a bond election to be held Nov. 29. The engineers are of the opinion the work can be completed within two years.

Engineer on Louisiana Board of Health Urged

The Louisiana Engineering Society is urging an amendment to a bill for the reorganization of the Louisiana State Board of Health so that one of the members will be an engineer. The bill now provides for a board of eight members, of whom five must be physicians, one a dentist, one a pharmacist, and one an educator. The existing board is composed of five physicians. Support for the proposed amendment is being given by the local press.

Minneapolis Regulates Vehicles

The city council of Minneapolis, on Sept. 9 passed an ordinance regulating the weight, width, height, and length of vehicles operating on the city streets. An unusual provision, according to information received from Ellis R. Dutton, assistant city engineer, is that the city engineer is authorized to restrict the use of streets for a period not exceeding 90 days when, in his judgment, any surface is being unduly damaged by vehicular use. This provision was included in the ordinance as a result of the destruction of certain dirt streets by a trucking and grading company engaged in making excavations and hauling the waste material. A contributory cause was the excessive truck loads hauled over paved streets, amounting, sometimes, to 20 tons or more.

The ordinance follows the uniform vehicle law and provides the following restrictions on vehicles: Maximum width, 96 in.; maximum height, 12 ft. 6 in.; maximum length, 30 ft. for a single vehicle and 85 ft. for a tractor-trailer combination. The gross load is fixed at 28,000 lb., the load per axle at 22,400 lb. and the weight per inch width of tire at 800 lb.

Unconventionality in Society Meeting Notices

They do things differently in Oregon. Here is one of the unconventional meeting notices issued by C. P. Keyser, secretary of the Portland Section, Am. Soc. C. E.:

"*Tandem aliquando*, and 'It's a long time,' since we had an old time technical meeting. We slipped, and are 168 hours late this month, but overhangs are pretty well cleaned up, and a *pleasant little* SOIRÉE is indicated.

UNIVERSITY CLUB, FRIDAY, OCT. 28, 8 P.M.

"The story relates to the great slide at Cascade Locks, and will be presented by no less a *raconteur* than our Sam Murray. Sam is incidentally a bridge engineer with a license, and is properly poking into the Bridge of the Gods. He has gone into this thing; dug in, actually looking for water, and what he found will surprise you. Discussion will follow, headed by at least three experts in the shifting of Oregon scenery—Williams, the geologist, Newell, loaded with antediluvian and other data pertaining, and Clarke, some checker in his own right.

"If you FEEL on the subject of LICENSE, wag, bristle, or yelp, or I will have to tell Humphrey that you seem to be satisfied with your collar.

"Looking forward to next month, we are to have another love feast with the contractors, but that will be different, perhaps irregular."

Engineering Societies

Calendar

Annual Meetings

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Meeting, New York City, Nov. 8-19.

CITY MANAGERS ASSOCIATION, Spartanburg, S. C.; Annual Meeting, Chicago, Nov. 14-16.

NATIONAL MUNICIPAL LEAGUE, New York City; Annual Meeting, Chicago, Nov. 16-18.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York City; Annual Meeting, New York City, Dec. 5-9.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS; Annual Meeting, Omaha, Neb., Dec. 5-8.

AMERICAN ROAD BUILDERS ASSOCIATION, New York; Annual Convention and Good Roads Show, Chicago, Jan. 17-20.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 18-19.

The Brooklyn (N. Y.) Engineers' Club made an inspection trip, Oct. 29, of the new piers at Stapleton, S. I.

The Engineers' Club of Philadelphia, (Pa.), announces the following speakers for its luncheon meetings: Nov. 15, "Humor in Business; A Cheerful Talk" by Albert B. Kelly; Nov. 22, "Accomplishments Under the Federal Water Power Act," O. C. Merrill; Nov. 29, "The Kansas City Board of Public Welfare—An Interesting Experiment in Civic Democracy," Jacob Billikopf.

The Texas Section, Am. Soc. C. E., at its annual meeting, Oct. 28, elected the following officers: President, Col. E. B. Cushing; first vice-president, E. E. Sands; second vice-president, Major W. J. Powell; secretary-treasurer, E. N. Noyes.

The Engineers' Club of Trenton, N. J., at its meeting Oct. 27 was addressed by Thomas H. Wiggin on, "Two Years' Experiences in China," illustrated with lantern slides. At the Nov. 10 meeting Robert Fleming will speak on "Building Codes," with particular reference to the proposed new building code for Trenton.

The Houston (Tex.) Engineers' Club, at its luncheon meeting, Oct. 18, was addressed by Thomas H. Ball, president of the Houston Harbor Board on "The Houston Ship Channel and Its Future." The following officers have been elected by the club: President, E. G. Maclay; first vice-president, E. M. Wise; second vice-president, R. J. Cummins; third vice-president, W. H. Mead; and secretary-treasurer, A. J. Banta.

American Public Health Association, Sanitary Engineering Section.—The first session of this section in conjunction with the fiftieth annual convention of the association, to be held Tuesday afternoon, Nov. 15, will be devoted to an address by the chairman, S. A. Greeley, Chicago, and to business matters. On the afternoon of Nov. 16 the section is invited to meet jointly with the American Society of Civil Engineers, at the United Engineering Societies Building, New York City, for a discussion of stream pollution and sewage disposal. At later sessions there will be committee reports and discussions on water supply and purification, sewerage and sewage disposal, garbage and refuse disposal, the milk supply, zoning and allied subjects. The meeting of this and other sections, and the general headquarters, will be at the Hotel Astor, New York City.

The Western Society of Engineers' November program, beginning Nov. 7, includes the following papers: "Illiana Harbor" by Col. W. V. Judson, U. S. Engineers; "Layout and Design of the Modern Industrial Plant" by Frank D. Chase; "Engineering Features of Chicago's New Gas Plant" by J. I. Thompson, chief engineer, the Koppers Co., and an "Experience Night" at which R. W. Hunt, P. W. Gates, H. C. Gardner and W. L. Abbott will give 15-min. talks on personal engineering experiences. In addition the Young Men's Forum has scheduled Saturday afternoon talks on "Business Management" and "Organization." On Nov. 5 a plan for a 10-weeks' course on public speaking will be perfected.

Personal Notes

EDWARD S. NETTLETON, acting city engineer of New Haven, Conn., has been appointed city engineer.

G. R. ABNEY has been appointed highway engineer of Angelina County, Tex., with headquarters at Lufkin.

ARTHUR L. WALKER, professor of metallurgy in the School of Mines, Engineering and Chemistry of Columbia University, has been elected a member of the board of Engineering Foundation, which is organizing industrial research on a nationwide scale. Prof. Walker, internationally famous as inventor and teacher, succeeds Dr. Joseph W. Richards of Lehigh University, eminent metallurgist, who died recently.

J. P. WEHRUNG has been appointed district engineer for the Falls County Road District No. 5, with headquarters at Chilton, Tex.

CLARENCE B. HOOVER has been appointed superintendent of waterworks and sewers, Columbus, Ohio, to fill the vacancy caused some months ago by Jerry O'Shaughnessy. Mr. Hoover was graduated from Ohio State University in 1903 and has been connected with the public works of Columbus since 1904, having long been in charge of the sewage-works and recently having been engineer in charge of important water-works extensions. He is a brother of Charles B. Hoover, chemist of the Columbus water purification plant.

PROF. C. J. TILDEN, who has been director of the Highway and Highway Transport Education Committee, Washington, D. C., since Dec. 1920, has returned to Yale University, to resume his duties as professor of engineering mechanics.

WALTER MOORE, JR., has resigned as promotional engineer with the Portland Cement Association to become manager of the Southern California chapter of the Associated General Contractors of America. He was formerly district engineer for the Los Angeles County Road Department.

ROBERT L. E. WARD, formerly with the Weiland Engineering Co.,

Canon City, Col., has been appointed city engineer of Canon City.

E. P. WATSON, JR., has been appointed chief engineer for the highway commission of Imperial County, Cal.

E. L. DALTON of Dallas, Tex., has been appointed supervising engineer for water-works improvements at Ferris, Tex., and for street improvements at Mexia, Tex.

D. L. STRUTHERS, formerly of Wilmington, N. C., has been appointed highway engineer for Gaston County, with headquarters in Gastonia, N. C.

LT.-COL. FRANK B. KING, during the war in command of the 112th Engineers in France, is in charge of water and sewer extension work at Duncan, Okla., for V. V. Long & Co., consulting engineers.

GEORGE F. PORTER, chief engineer, Canadian Bridge Co., Ltd., Walkerville, Ont., has received the honorary degree of Doctor of Laws from McGill University.

A. W. K. BILLINGS has returned from Barcelona, Spain, to act as construction manager for the English and Canadian interests controlling large public utility companies in Mexico, Brazil and Spain, and as vice-president of the Canadian Engineering Agency, Inc., New York City. During the war Mr. Billings was in charge in Europe of naval aviation construction work ashore. He was promoted to the rank of Commander in the Naval Reserve and was awarded the Navy Cross and the Legion of Honor.

COL. C. S. COE, formerly engineer with the Florida East Coast Ry., has been appointed city manager of Miami, Fla.

ARTHUR H. BLANCHARD, professor of highway engineering and highway transport at the University of Michigan, has received notice from Paris of his appointment as representative of the executive bureau of the Association Internationale Permanente Des Congres De La Route to select the United States reporters on seven topics in the fields of highway engineering and highway transport to be discussed at the fourth International Road Congress to be held in Spain in 1923.

OBITUARY

RALPH E. ROBSON, associated with the engineering firm of Cope, Rand, Means & Co. of San Francisco, was killed recently in an automobile accident while driving over work on which he was engaged in northern California. Mr. Robson, gained an enviable reputation for his service as an engineer officer in the American Expeditionary Force having been decorated by the Belgian government for his work in that country. Mr. Robson left the service with the rank of major.

FRANCIS L. DORMANT, formerly city engineer of Houston, Tex., and recently city engineer of Palestine, Tex., died in Houston, Oct. 12.

GEORGE R. HENDERSON, consulting engineer, died in Philadelphia, Pa., Oct. 20. He was born in Philadelphia in 1861 and began his career in the Pennsylvania R.R. shops at West Philadelphia and Altoona. He was later associated with the Norfolk & Western Ry. and the Santa Fe System, the Schenectady Locomotive Works, and the Baldwin Locomotive Works. In 1915 he began a consulting practice in Philadelphia. He acted as consulting engineer for railroads in Brazil, the Philippine Islands, and several in the United States.

A. T. BROOKINS, for 25 years junior engineer in charge of harbor inspection work for the Corps of Engineers, U. S. A. in Grand Rapids, Mich., died Oct. 13. He was born in Shoreham, Vt., 1869, and was a graduate of the civil engineering department of the University of Vermont.

WILLIAM H. RONEY, contractor, bridge, structural and fire-proofing engineer, died Oct. 16 in Alhambra, Cal. He was born in Warren County, Ill., 1857. His first position was bookkeeper and draftsman for Wuichet & Co., sheet metal works, Dayton, Ohio, and later he was draftsman and sales engineer for the Columbia Bridge Co. at Dayton. In 1889 he became engineer, and later shop manager, with the Lane Bridge & Iron Works, Chicago. In 1897 he engaged in preliminary tests and development of reinforced hollow tile construction for E. V. Johnson at Chicago. In 1898 he was experimental engineer for John S. Metcalf & Co., Chicago; James L. Record of Minneapolis, and E. V. Johnson, Chicago, on fireproof construction for grain elevators. In 1899 he entered private work as an engineer and contractor. He also was consulting engineer for the National Fireproofing Co., and planned its first testing laboratory at Chicago. In 1912 he wrote the "Collation of Tests of the Resisting Qualities of Terra Cotta Structural and Fire-proof Material," which was published by the above company.

BUSINESS NOTES

J. C. TOWNLEY, formerly manager of the Pittsburgh office of the Cement-Gun Co., Inc., sailed for Holland Oct. 15, where he will become general manager of the International Cement-Gun Co., Utrecht, Holland, organized to handle for the Cement-Gun Co., Inc., its foreign business, with the exception of Canada, Mexico and Cuba.

THE CONSOLIDATED EXPANDED METAL COMPANIES, Braddock, Pa., announce the opening of a direct factory branch office and Eastern distributing warehouse in New York City, under the direction of Thomas R. Herbst, Jr., who during the past seven years has established and operated similar distributing stations for the company in Philadelphia and Pittsburgh.

ALAN A. WOOD, for a number of years connected in an engineering and sales capacity with the Providence plant of the Builders Iron Foundry and the Diamond Machine Co., associated companies, is now sales manager of the Philadelphia district, with office in Philadelphia.

E. G. LEWIS, formerly Central sales manager of the Bucyrus Co., with headquarters at Chicago has been appointed Eastern sales manager in charge of the New York office. M. J. Woodhull will succeed him at Chicago, and E. R. Weber has been appointed Northern Sales manager at Minneapolis to succeed J. N. Gawthrop, who will become associated with Mr. Lewis at New York.

EQUIPMENT AND MATERIALS

Swing Bridge Operated by Gasoline Engine

Across the Wilmington River in Chatham County, Ga., there is a steel swing span of a length of 229 ft. 10 in., a height of 22 ft. between the center lines of the truss chords, and a width of roadway of 20 ft. between the center lines of trusses, which is operated by a 6-hp. gasoline engine manufactured by the Gray Motor Corporation at Detroit, Mich. The total weight which is swung is 166 tons and the time to swing the span through an arc of 90 degrees is about two minutes. The gasoline engine is of the marine type with two cycles.

Self-Winding Electric Cable Reel

A reel on which an electric cable can be wound and unwound and locked in any position, after the manner of an ordinary window shade, is being sold by the Wayne Engineering & Equipment Co., London, Eng. The reel is 14½ x 4 in. in size and has a standard by which it is attached to wall or ceiling. It holds 25 ft. of cable which can be unreeled as little or as much as is desired and so "spot" the attached lamp or tool wherever it is wanted.

Steel Sections for Anchoring Shaft Hangers

For supplying anchorage for shaft hangers, piping on columns or walls, or anchoring machinery, such as electric motors, to concrete floors, the Midwest Steel & Supply Co., New York City, has developed a line of steel sections, chief among which are its ankerails—box rails, and "L" rails. The ankerails are continuous inserts made of rolled steel to be embedded in ceilings, walls, and columns of factories for the purpose of fastening shaft hangers, trolleys, pipes, cables, etc. They also serve as reinforcing bars for the reinforced-concrete members in which they are embedded. With a box rail embedded in the concrete it is possible to hang shafting at most any place simply by inserting a bolt into the desired point, turning about 90 deg. and pulling down the bolt until the grooves in the head fit over the vertical ribs of the rail. In contrast to the box rail, the "L" rail is a solid steel bar so placed in the concrete beams and girders that suitably-formed bolts can be easily attached to it by moving the concrete covering at such points. The anchorage of the "L" rail is provided by the ordinary stirrups.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Trade Revival Seen in Federal Reserve Board Report

The cut in the discount rate of Federal Reserve banks, the activity of the War Finance Corporation in behalf of cattle and sheep raisers, a general improvement in the live-stock situation, the rapid marketing of agricultural products which carried along a stimulus in other important lines of industry and trade, are only a few of the conditions indicating a trade revival, according to prominent government officials and the recent report of the Federal Reserve Board.

In its report the Federal Reserve Board asserts that "Improved collections and reduction of outstanding loan accounts have followed in the strain of this renewed activity. The beginnings of improvement are noticeable, even in portions of the country, such as some of the southern and southwestern districts where credit conditions have been more serious than generally."

Some distinct and encouraging elements in the general business situation, the Federal Reserve Board finds to be: (1) The outlook in the textile industries is good; (2) there has been a more active demand for raw wool, especially of the medium grades; (3) a more active disposition than has been noted for weeks in the buying of cotton is present; (4) increase in both production and unfilled orders in the iron and steel trade; (5) improvement in the production and sale of non-ferrous metals; (6) increase in bituminous coal production and (7) activity in the lumber industry.

Production and Shipping Costs of Southern Pine

Since the first of this year the cost of manufacturing among the Southern Pine mills has decreased approximately 50 per cent. The cost per thousand feet, b. m., of logs, excluding the stumpage, and the milling cost is now $10.88 as against $21.88 for December, 1920, according to a cost statement recently issued by the Southern Pine Association. Including shipping, selling and depreciation, though excluding any interest on invested capital, the total cost now stands at $21.65 as against $37.27 for December of last year. The figure arrived at for December is taken from the reports received from 78 mills representing a total cut of 182,000,000 ft.b.m., and that for August of this year from the reports of 89 mills with an aggregate production of 305,000,000 ft.b.m.

Steel Exports Recover Slightly

Exports of iron and steel from the United States during September totalled 95,169 tons, compared with 75,827 tons in August, says a recent announcement from the U. S. Department of Commerce. The former figure, however, represents but 23 per cent of the tonnage exported during the corresponding month of 1920. Steel rails formed the largest export item, and more than half of the rails were exported to China.

Trend of Business

Stock Market—Oil stocks still command principal interest. Market generally reflects improving business and industrial affairs.

Bond Market—Heavy oversubscription for the new Treasury certificates and the reduction in the Federal Reserve rediscount rate to 4½ per cent have brought on a strong rise. Advancing bond prices with declining interest rates, result in rush to buy stronger issues at rising prices. New issues light, with municipals leading. Industrials and public utilities share in the rise, with the railroad list leading.

Money—Lowering the interest rate by about 1 per cent on the new Treasury certificates have made the money market easier and boomed the bond market. Call money plentiful.

Foreign Exchange—Further weakness in the German mark (par 23.8 cents; present .35 cents), not reflected in other exchanges. Sterling strong around $3.94, with exchanges on Paris, Rome and Amsterdam rising.

Retail Food Prices Declined in nine of eleven American cities from Sept. 15 to Oct. 15. The decreases were: Milwaukee, 3 per cent; Chicago, Detroit and Indianapolis, 2; Peoria and St. Louis, 1; Newark, 0.1; Bridgeport and Minneapolis, 0.4. No change in Columbus, and an advance of 1 per cent in Mobile. As compared with average retail cost in 1913, the increases on Oct. 15, 1921, were 54 per cent for Detroit; 50@53 for Chicago, St. Louis, Milwaukee and Newark; 47 for Indianapolis and Minneapolis.

Wholesale Prices in September still held the Bureau of Labor Statistics Index of 152 for all commodities, as in August, as against 242 in September, 1920.

Cost of Living in 32 American cities declined 1.7 per cent from May to September, 1921, and 18.1 since June, 1920. The average declines since 1913 are: Food, 53.1 per cent; clothing, 92.1 per cent; housing, 60; fuel and light, 80.7; furniture and furnishings, 124.7; miscellaneous. 107.8, making a total of 77.3, according to the Bureau of Labor Statistics.

Iron and Steel Workers in 106 establishments numbered 106,690 in September, as against 183,873 one year ago, and the respective payrolls were $14,288,398 and $4,131,241.

Unemployment Relief Plans Being Carried Forward

Iowa Contractors Meet with A. G. C. Officers—Canadian Government Makes Program Known

Contractors from all parts of Iowa and representative of all classes of construction met in Des Moines recently to listen to various officers of the Associated General Constractors of America and to form some sort of an organization to stimulate construction as an aid to employment. The meeting was under the auspices of the Iowa Street and Highway Service Bureau and that organization, subsequent to the meeting with the A. G. C. officers, has bent every effort to induce city officials and state department to let public work soon. The mayor of Des Moines has called a committee to function along these lines, and from reports the contractors association is receiving from other cities of the state city officials are doing everything possible to relieve the unemployment situation in their respective localities.

Wide publicity has been given throughout the state to the results secured from the unemployment conference held by the contractors, and it is hoped that this interest may be translated into results.

Included among the speakers who addressed the Iowa Street and Highway Service Bureau and the other contractors were F. L. Cranford, G. A. Garber, and J. H. Ellison.

Acceptance of appointment as regional directors on behalf of the President's Conference on Unemployment have been received from thirteen men throughout the United States, according to word received from the U. S. Department of Commerce. These regional directors will keep the mayors in their respective cities informed of the work being carried on by the committee on civic and emergency measures in Washington and to act as a source of closer contact between the mayor's unemployment committees and the standing committee of the President's Conference.

The committee on civic and emergency measures is receiving almost daily reports from cities throughout the country on work being carried forward by local unemployment committees. Status of employment in 42 New York cities was included in a message recently received by the chairman of that committee from Governor Miller, of New York. Reports from many cities were to the effect that public works construction was being greatly stimulated as a means of unemployment relief.

Already considerable effective work has been done in Milwaukee, Wis., for the relief of the unemployed through the unemployment committee of the Milwaukee Association of Commerce. This committee consists of manufacturers, public officials, labor leaders, and contractors, and is presided over by a director of the General Contractors Association of Milwaukee—F. R. Bell.

The general committee has been subdivided into groups as follows: Public works, private industries, factories, and general welfare. The program that has been outlined has been practically identical with the one outlined at the President's Conference on Employment. So far over $2,000,000 worth of work which had been held in abeyance has been released and is now well under way, activity which is attributable to the effective work done by the unemployment committee.

After careful consideration, taking into account the experiences of the winter of 1920-21, the Canadian Government has determined upon a definite course of action in assisting municipalities in relieving the unemployment situation. The government considers that, inasmuch as unemployment is primarily a municipal question though one in which the province itself also shares, practically all of its assistance should be through municipalities. The government therefore proposes to participate in the cost of work provided by municipalities on the following basis:

(1) Municipality to bear the normal cost, that is to say the cost of carrying on the work in the normal working season; (2) estimate of normal cost to be approved by the federal government's engineers and the Department of Public Works; (3) that municipal, provincial and federal governments bear equally and jointly the actual cost over the estimated normal cost, thereby encouraging the creating of employment where possible; (4) That where work cannot be provided the federal government continue to refund one-third of the investment actually made by a municipality for unemployment relief, conditional upon the provinces participating on an equal basis.

Plea For Disarmament From Building Materials Maker

A circular letter, sent out by the Charles Warner Co., Philadelphia, manufacturers and distributors of building materials, is to the effect that, if the American citizen is "wise he will pray that the spirit of forbearance rather than the spirit of might and force shall rule the hearts and minds of the conference members" attending the arms conference to open this week in Washington. The necessity of protecting American capital in European enterprises makes it incumbent upon the government, hints the circular, to forget Washington's warning about the dangers of entangling alliances abroad.

PUBLIC BOND SALES OF SEPTEMBER AND OCTOBER, 1921

State	Purpose	Amount	Maturity	Rate per Cent	Sold for	Dated
Delaware	Highway	$ 500,000	1922–1961	4½	92.18	Jan. 1, 1921
Illinois	Highway	5,000,000	1926–1935	4	94.02	Nov. 1, 1921
Oregon	Highway	2,000,000	1931–1951	5	100.00	June 1, 1921
County						
Brown, Wisc.	Highway	150,000	1941	5	99.05	Oct. 1, 1921
Crow Wing, Minn.	Road	75,000	.....	5½	100.90	.....
Newton, Ind.	Ditch	171,000	1931	6	100.00	Oct. 24, 1921
Orleans, N. Y.	Highway	35,000	1928	6	103.82	Nov. 1, 1921
Porter, Ind.	Road	73,000	1922–1931	5	100.00	Oct. 15, 1921
Stevens, Minn.	Drainage	29,916	.....	5½	100.50	Oct. 1921
Sumter, S. C.	Road, Bridge	500,000	1926–1950	6	100.053	July 1, 1920
Washington, N. Y.	Highway Improvement	285,000	1923–1942	5	102.899	Nov. 1, 1921
Becker, Minn.	Ditch	22,500	1927–1940	5½	100.46	Oct. 1, 1921
Township						
Cambria, Cambria Co., Pa.	Road	70,000	$11,000–1927 15,000–1933 20,000–1939 24,000–1945	5½	101.107	Aug. 1, 1921
Municipality						
Attleboro, Mass.	Street Improvement	58,000	1922–1925 1926	5½	101.241	Oct. 1, 1921
Greenwich, Conn.	Sewage Disposal	104,000	1922–1929	5½	101.07	June 1, 1921
Hammond, Ind.	Water Works	375,000	1922–1926 1927–1951	6	105.348	Oct. 15, 1921
Lockland, Ohio	Street Improvement	5,000	1922–1931	6	100.111	Aug. 1, 1921
	Sewer	5,000	.....	..	.....	.....
Los Angeles, Cal.	Harbor Improvements	1,600,000	1922–1961	5½	102.54	Nov. 1, 1921
Minot, So. Dak.	Sewage Disposal	10,000	1922–1940	4	100.00	Apr. 1, 1920
New Wilmington, Pa.	Paving	13,900	Due serially Int. M. & S.	6	100.00	Sept. 26, 1921
Randolph, Neb.	Paving	20,000	1940	6	100.00	Nov. 1, 1920
St. John, Kan.	Paving	80,000	.....	6	100.00	Oct. 1920
	Internal Improvement	74,741	.....	..	.....	.....
Smithfield, Utah	Water Works	35,000	$2,000 (1926-30) $2,500 (1931–40)	6	100.00	Sept. 1, 1921
	Improvement	.....				
Walla Walla, Wash.	Water Extension	500,000	1924–1931	6	101.17	July 1, 1921
Albany, N. Y.	Water System Improvem't	100,000	1922–1941	5½	101.11	Oct. 11, 1921
	River Front Improvement	40,000	.....	..	.....	.....
Catahoula Parish Road Dist., La.	Roads	690,000	1921–1960	5	100.00	Feb. 1, 1920
Center, Col.	Water Works	30,000	1936	6	91.55	Sept. 1, 1921
Chico, Calif.	Street Paving	19,261	1921–1936	7	100.00	Aug. 24, 1921

Close Bidding on Texas Road Job

The contract for building the Bankhead Highway, 102.69 miles long and extending across the Texas Counties of Howard, Martin, Midland and Ector, was awarded recently to the Womack Construction Co., McKinney, Texas, with the understanding that the road be completed within 18 months. Ten contractors submitted bids ranging between $759,231.36 and $823,085.13, the successful bidder submitting the former bid, which does not include 10 per cent for engineering and contingencies. The engineer's estimate, excluding the 10 per cent addition, was $764,730.63.

The highway will be 16 ft. wide on a 24-ft. roadbed, with an 8-in. gravel surface. Gravel will be obtained from a 25-acre pit, owned jointly by the counties, and located at Big Springs. The contractor will install and operate the loading plant and ship the gravel to points of delivery.

The accompanying tabulation gives the range of unit bids:

Item	Unit	Totals for the Four Counties	Range in Unit Prices Low	High
Earth excavation	Cu.Yd.	$129,477.40	$0.12½	$0.24
Borrow excavation	Cu.Yd.	224,697.70	.11½	.19
Loose rock excavation	Cu.Yd.	3,552.20	.30	1.00
Solid rock excavation	Cu.Yd.	10,839.70	1.00	1.75
Overhaul	100 Ft.	144,620.56	.02	.06
Road-grader work	100 Ft.	3,096.49	4.70	11.00
Gravel, f.o.b. delivery point	Cu.Yd.	206,363.58	1.37	2.63
Gravel hauled and placed 1st ½	Cu.Yd.	206,363.58	.40	.60
Gravel hauled add. ½	Cu.Yd.	1,131,982.95	.06	.09
Reinforcing steel	Lbs.	240,157.00	.05½	.07
Structural exc. (dry)	Cu.Yd.	2,648.00	.35	1.15
Concrete 1:2:4 in place	Cu.Yd.	2,597.19	19.50	28.50
Concrete 1:2½:5 in place	Cu.Yd.	233.01	18.75	28.50
Concrete 1:3:6 in place	Cu.Yd.	4.80	18.00	27.00
Rolling	Per Hr.	2,360.00	1.50	4.50
Water hauled 1st mile	M.Gal.	926.50	1.75	5.50
Water hauled add. mile	M.Gal.	1,340.10	.50	3.50
Wooden guard fence	Lin.Ft.	1,000.0	.40	.85

Building Trades Unionists Gain In Numbers

There has been an increase in the membership of the international unions which form the building trades of 63,000 within the past year, according to a recent report of the secretary-treasurer of the building trades department of the American Federation of Labor. There is now in good standing an average membership of 866,735 as against 803,920 for last year. The greatest gains have been in the following trades: united brotherhood of carpenters and joiners, electrical workers of America, brotherhood of painters, decorators and paperhangers.

Southern Pacific Places Large Rail Order

Announcement was recently made by the Southern Pacific R. R. that it had placed with the Tennessee Coal and Iron Co. an order for 44,600 tons of steel rails for 1922 delivery. This is one of the largest single orders for rail placed with the Steel Corporation within recent months.

Railroads Preferred Borrowers

According to a report made at the recent meeting of the Investment Bankers Association of America, New Orleans, La., notwithstanding the fact that the railroads of the United States during the last twelve months have been in such serious financial condition due to the impairment of earning power, a tribute to the attitude of the investor toward railroads is found in the fact that the railroad corporations have been

the preferred borrowers. The railroads have borrowed money at about three-quarters of 1 per cent cheaper than any one else.

In other words, the railroad securities which have gone to the public since the first of the year have averaged about 6.5 per cent yield, public utility securities have yielded about 7½ per cent, industrials about 7¾ per cent, and foreign governments about 8¼ per cent.

Upon the theory that it might undermine credit, the convention was urged by Pierpont Davis of the National City Bank of New York, through the committee on railroad securities, to recommend that the Interstate Commerce Commission continue 6 per cent as the statutory or suitable rate of return for railroad earnings. The 6 per cent statutory definition expires March 1, 1922.

Average Earnings of Factory Employees Increases

The average earnings of New York State factory workers increased 17c. from July to August, says a recent issue of the *Labor Market Bulletin* published from the office of the chief statistician of the New York State Department of Labor. The higher average of earning of factory workers in August is accounted for for the most part by the increased working time. Another factor was the retention in some industries that were still on the decline of the higher paid and more important employees, while the lower paid and less skilled employees were laid off. Improved demand, partly seasonal, was the reason for the increased working time in many factories.

The average weekly earnings of factory workers have decreased $3.28 from August, 1920.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of November 3; the next, on December 1.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products:									
Structural shapes, 100 lb	$2.88	$4.00	$4.00	$2.88	$3.16	$3.75	$3.70	$4.00	$4.00
Structural rivets, 100 lb	3.70	5.25	5.50	3.68	4.15	4.25	5.50	4.50	6.50
Reinforcing bars, ¾ in. and larger, 100 lb	2.78	3.20	3.50	2.78	3.18	3.57½	+2.90	3.75	−3.25
Steel pipe, black, 3½ to 6 in. lap, discount	51%	52.65–5%	45%	65½%	58.9–5%	38%	51.8%	+50%	−6%
Cast-iron pipe, 6in. and over, ton	+47.30@48.30	40.50	54.30	42.60@44.10	47.80	52.00	50.00	53.00	60.00
Concreting Material:									
Cement without bags, bbl	2.40	2.60	2.55	1.97	2.26	3.10	2.84	3.10	+3.12
Gravel, ¾ in., cu.yd	—1.75	2 00	2.25	1.65	1.50	2.50	2.25	1.50	1.50
Sand, cu.yd	1.25	1 35	2.25	1.65	.50	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.80 to 1.90	2.25	3.20	1.60	2.25	3.50	2.25	3.00	2.10
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	45.00	38.00	+37.00	48.00	36.00	50.00	+31.00	24.00	120.00
Lime, finishing, hydrated, ton	16.99	19.00	25.00	18.00	29.00	30.00	22.00	27.50	21.00
Lime common, lump, per bbl	3.69	1.60	2.75	1.40	1.40	2.95	1.90	2.75	15.00
Common brick, delivered, 1,000	18.40	11.00	12.72	11.00	17.00	14.00	18.00	14.00	16.00
Hollow building tile, 4x12x12, block	Not used	— 10	.124	.0821	.092	.09	.12½	.10	.08@.29
Hollow partition tile 4x12x12, block	—.11120	—.10	.124	.0657	.092	.10	.14½	.11	.....
Linseed oil, raw, 5 bbl. lots, gal	—.72	.85	.93	—.74	+.80	—.90	.83	.79	—.85
Common Labor:									
Common labor, union, hour	.75@.80	.35	.....	.72½	.50	.50@.55	.75	.50@.60	...
Common labor, non-union, hour	.....	.20	.35@.45	.35@ 40	.50	.35@.40	.50@.55	.50	.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent, 45@50 means a range of 45 to 50 per cent. Charge of 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over. **New York** quotations are delivered except tiles, which are "on trucks." Common lump lime per 280-lb. net; both lump and hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. Cement delivered to contractors on job. **Chicago** quotes hydrated lime in 50-lb bags; common lump lime per 180-lb. net. **Minneapolis** quotes on fir instead of pine. Brick and hollow tile delivered. Cement on cars; $2.45 delivered. Gravel, sand and crushed stone quote at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized. **Denver** quotes cement "on tracks"; gravel and sand at pit, stone on cars, lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. **Atlanta** quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. **Dallas** quotes lime per 180-lb. bbl. Steel, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. **San Francisco** quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Lumber prices are delivered "at ship tackle in San Francisco ex mill." **Seattle** quotes on Douglas fir instead of pine; and on lime in paper bags. **Montreal** quotes sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile, per ft. Cement price is in Canadian funds, exchange with the United States being 14 per cent at present. Bag change is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment.

Changes Since Last Week

Structural steel shapes, plates and bars are still quoted at the Pittsburgh mills at $1.50@$1.65 per 100 lb., the lower figure applying mostly to the larger tonnages; small tonnages selling at $1.60@$1.65. Mill shipments of structural shapes are quoted in Denver at $3.05 and in New York at $1.88@$2.03; bars at $1.80@$1.88. Reinforcing bars have advanced 55c. in San Francisco and declined 50c. per 100 lb. at Montreal warehouses. An increase of one per cent is reported in black steel pipe discounts in Montreal and a decrease of 5 per cent in Seattle. New York quotes cast-iron pipe at $47.30@$48.30 as against $45.30 per ton, and gravel at $1.75 as compared with $2 per cu.yd. formerly.

Increased demand for steel products and other construction materials is marked by advances in price quotations, while decreases are effected in many instances to stimulate buying. Lumber prices, particularly, have shown this tendency to stiffen with increasing demand.

Longleaf yellow pine is quoted in Dallas at $37 as against $35, and in San Francisco at $31 as compared with $29 per M ft., previously. Seattle reports an advance of 50c. per M ft. in Douglas fir, 1 in. rough, 10 in. x 16 ft. Common birch, base size, is quoted in San Francisco at $15.50 per M ft. The market on hollow tile is reported very unsettled in Atlanta, with both building and partition tile quoted at 10c. as against 14c per block. New York quotes hollow partition tile at 11.12c. as compared with 11.37c. per block formerly.

Linseed oil has dropped 1c. in New York, 2c. in Denver, 5c. in Montreal and 6c. per gal. in Chicago. Minneapolis reports an advance of 4c. per gal. in 5 bbl. lots.